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EXPERIMENTS ON SHIPPING WASHED POTATOES FROM

CENTRAL NEBRASKA AND GILCREST, COLORADO DURING JULY AND AUGUST, 1942 1/

(A Preliminary Report Prepared for Information  
of Cooperators. Not for Publication)

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INTRODUCTION

Shipping tests conducted with three varieties of Nebraska potatoes during the shipping season of 1941 showed quite definitely that those shipped during July and August from central Nebraska arrived in better condition when refrigerated or precooled than when shipped under standard ventilation. These tests also indicated that the 5-3-2-1 pyramid load was preferable to the aisle load. A generally similar series of tests was made during the 1942 shipping season with Colorado and Nebraska potatoes. In this series all loads were of the pyramid type and no shipments under ventilation were included. The addition of icing facilities at Grand Island made it possible to preice the cars this season and most of the shippers used this service. Consequently, most test shipments involved comparison of iced, preiced, and precooled cars of potatoes. When cars were preiced, the preicing was done either the night before, or the second night before loading. The potato investigations in 1942, in addition to the shipping tests, included field tests to determine the effect of temperature, humidity, and method and length of exposure on two varieties of Colorado potatoes.

1/ The assistance and cooperation of the following individuals and agencies is gratefully acknowledged: (1) H. O. Werner and R. D. Pelkey, University of Nebraska; (2) H. L. Peterson, Agricultural County Agent, Kearney, Nebr.; (3) Harold W. Benn, and J. W. Jarvis, Union Pacific Railroad; (4) L. V. Foyne, County Agricultural Agent, Greeley, Colo.; (5) Department of Horticulture, Colorado State College; (6) M. D. Sanborn and various inspectors of the Agricultural Marketing Administration; (7) M. A. Smith and Barbara O. Heiberg, Bureau of Plant Industry, U. S. Department of Agriculture, Chicago; (8) Pacific Fruit Express Co.; (9) The Burlington Refrigerator Express Co.; (10) Ralph Killingstad and employees of Shippers Precooling Service; (11) Central Nebraska Potato Growers Assoc., W. M. Morrow, Mgr.; (12) Gilcrest (Colo.) Early Potato Association, Spence Bowser, Mgr.; (13) Elmer Peterson; (14) Franz Pender; (15) S. A. Skaats; (16) Herbert Campbell Company; (17) McConnell Bros.; (18) Peterson & Co.; (19) Buda Growers Cooperative; (20) Dean Camp; (21) Richard Ross & Sons; (22) Albert Miller & Co.; (23) M. W. Frissell & Co.; (24) C. R. Buller & Co.; (25) Rodney Smith; (26) Atlantic Commission Co.; (27) National Produce Company; (28) Friedman & Son; (29) R. A. Koltz and Co.; (30) United Produce Co.

The precooled shipments were serviced by the mobile mechanical units of the Shipper's Precooling Service. The results with shipments under precooling service as compared with those with shipments under various methods of icing are shown in the inspection reports on the condition of the potatoes on arrival and after seven days storage, and in the temperature tables.

The Pacific Fruit Express Company made available several of its new cars provided with floor fans for some of the tests. While it seemed doubtful that such equipment was necessary to provide suitable conditions for shipping potatoes it was desirable to see what temperatures might be obtained in the type of cars commonly shipped from Nebraska and Colorado. A comparison of the temperatures obtained in the fan equipped cars with those in the regular cars may be found in Tables 7, 9, 12, 14, 15, 17, 24, and 26.

In order to get accurate readings of the temperatures obtained in some tests of special interest, electric resistance thermometers were placed in twelve different locations in the cars. Four of these thermometers were placed at the bunker, four at the quarter length, and four at the doorway. At each position a thermometer was placed in the center row of the bottom layer of bags, the outside row of the bottom layer, the center row of the second layer, and the center row of the top layer. In these cars temperature records were procured at the beginning and end of precooling and at Grand Island, Council Bluffs, Galesburg, and Chicago. These temperature data will be found in special tables at the end of the description of these shipping tests.

Information on the carrying quality of potatoes under the conditions maintained at three critical locations in the load was obtained from three test bags of potatoes in each car located as follows: Bag A - bottom bunker; Bag B - middle layer quarterlength; Bag C - top layer doorway. In the center of each test bag of potatoes was placed a thermograph which made a continuous record of the temperature from the time the cars were loaded until the bags were removed at Chicago. Most cars were delivered in Chicago the third day. In the tables that follow the potato temperature at loading is indicated under the caption "0 hours" and the transit temperatures are shown at twelve-hour intervals.

To insure uniform quality of potatoes used in test shipments, enough 100-pound bags of potatoes were obtained at the grading sheds to provide three test bags per car for all cars shipped on a given date. In each test bag 100 tubers were inspected at loading time to determine the percentage of (1) decay, (2) browning, (3) bruising, and (4) scald spot. Upon arrival at Chicago, the test bags were removed from the cars and 100 tubers from each bag were inspected to determine the percentage of each of the four condition factors listed above. The remaining tubers in each test bag were stored in a basement where the average daily temperature was 78° F. and the relative humidity 65 percent. After storage for one week under these conditions, another lot of 100 tubers was inspected from each test bag. Only commercially significant blemishes and decay were scored in these inspections. Most of the decay was in the early stages on arrival and stock so affected could be sold at a discount, but the decay found after one weeks storage was generally so far advanced as to make the affected potatoes worthless.



Loss of weight during transit was obtained in most shipments by weighing test bags A, B, and C, at loading time and reweighing them when unloaded at Chicago. This loss is given in pounds per bag in the tables. Since most of the potatoes were still somewhat wet from washing when weighed at loading time, the loss in weight during transit was partly due to evaporation of surface moisture.

In order that a better understanding may be had of the notes and tables that follow, the significant condition factors scored in these test shipments are described in the following paragraphs.

Bacterial Soft Rot is usually the most serious decay of washed early potatoes. It is a sticky, soft, or slimy type of rot that develops rapidly under warm, moist conditions. The bacteria that cause this decay are in the soil and water but they are unable to invade normal, healthy tissues. For this reason, only tubers injured by bruising, skinning, scalding, or other means are subject to this decay. Bacterial soft rot is more serious following scald and scald spots than any other type of injury. However, badly skinned and bruised tubers and those having enlarged lenticels are also very susceptible to decay under some conditions.

Scald denotes localized spots or areas on the unskinned surface of tubers that have been injured by exposure to hot, bright sunlight, or to heat. Freshly harvested potatoes coming in contact with extremely hot surface soil are sometimes scalded. In cases of severe injury the affected area may become slightly watery or even blistered. On colored tubers the skin is sometimes bleached, especially if strong sunlight is an important factor. Unfortunately, scald does not become visible on potatoes until several hours after the injury has taken place, consequently many scalded tubers may be loaded and shipped without knowledge of the presence of this injury. Potatoes affected by scald usually develop a very high percentage of bacterial soft rot during transit and marketing.

In recent years scald has been found only on rare occasions. Most potato growers and shippers are now fully aware of the danger of exposing immature potatoes to bright sunlight and heat, and make it a general practice to pick up the potatoes promptly after they are dug.

Browning is the term used to describe the discoloration of skinned areas on immature tubers. Although some browning occurs eventually in any injured tissues exposed to the air it is most serious on skinned tubers that are exposed to the drying effect of hot wind in the field or packing shed. Air movements in loaded cars may also contribute to this type of discoloration. Slight browning is not objectionable except when large areas are involved and excessive withering results on account of loss of moisture. Severe browning not only affects the market value of the potatoes on account of appearance, but predisposes them to a sticky type of bacterial soft rot if they become moist or are placed in a humid atmosphere.

Severe browning of tubers in localized spots or small areas that become definitely sunken due to rapid desiccation of injured tissues lead to the condition referred to as "scald spot."

"Scald spot" has been used in this report to designate one of the serious injuries often found in Nebraska and Colorado potatoes. Although this term does not adequately describe the type of injury indicated, it was thought most satisfactory in the present instance because growers and shipping-point inspectors have become accustomed to using this term to describe certain oval or irregular, sunken, brown areas that occur on skinned areas of tubers that have been exposed to dry, warm air. The terms "wind scald" and "wind burn" have been suggested, but neither of these is satisfactory since factors other than wind can cause this injury. It has been demonstrated that these sunken brown spots are developed where the epidermis has been rubbed off and the underneath tissue exposed to the drying effects of the air. Although high temperatures increase the rate of discoloration and drying of the tissue, the same type of injury may be produced at moderate temperature.

Potatoes picked up and sacked immediately after digging have been found injured by browning and scald spots after standing in the field for as short a period as one hour on a hot windy day, or overnight under dry windy conditions. It has been observed that most injury occurs when the tubers are exposed to hot, dry winds in the field and at the loading sheds. In a great many instances these scald spots become dry and "heal" enough to prevent infection, but when such injured tubers are loaded wet the surface of the "scald spot" area becomes susceptible to infection by bacteria, and a sticky type of bacterial soft rot often develops.

Some experimental field tests were made to determine the effect of temperature and humidity on the development of browning and scald spots on Colorado potato. The high percentage of injury obtained in one test (Table 1) is especially interesting as it was made on a day that growers felt would not result in scald spots, because of the coolness. The shade air temperature at 9:15 a.m. was 63°F. and rose gradually to a maximum of 75° at 5 p.m. The relative humidity at 9:15 was 73 percent. It dropped gradually to a minimum of 40 percent at 2 p.m. and rose slightly thereafter to a maximum of 43 percent during the test. The potatoes exposed in the sun never got higher than 92.5° and those exposed in sacks no higher than 87.5°. Air velocities were quite high, being around 700 to 800 feet per minute in the morning and from 200 to 400 feet per minute in the afternoon. As shown in Table 1, the percent of injury was quite high on all exposed potatoes regardless of whether they were spread out or in sacks. As would be expected, the injury was most severe when the potatoes were exposed spread out. An exposure of tubers for 15 minutes spread out or one hour in sacks resulted in severe injury even in the cool of the morning. Injury was even more severe when the tubers were exposed shortly after noon when the temperature was higher and the relative humidity lower. In a similar test (Table 2) when the air velocity was lower there was less injury to the potatoes even though the air temperature averaged about 10 degrees higher than in the other test. The shade air temperature reached a maximum of 88°. It is apparent from these results that exposure of potatoes to heat and drying, either spread out or in sacks, may lead to serious injury from browning and scald spots, especially on a windy day. Similar results have been obtained by the Department of Agriculture in other sections of the country.

Table 1. Influence of method and length of exposure on browning and scald spots of Bliss Triumph potatoes, Gilcrest, Colorado, August 13, 1942 - Inspected August 15.

Method of exposure	Length of exposure Min.	Browning and scald spots on skinned areas		
		Dug 9:15 a.m. Percent	Dug 1:15 p.m. Percent	Dug 4:15 p.m. Percent
--	0	0	8.6 (slight)	0
Spread out	15	31.4	89.5	2.9
Do.	50	51.3	88.5	69.1
Do.	60	75.9	93.4	93.9
In sack	60	29.9	37.1	--
Do.	120	58.6	62.5	--
Do.	240	73.2	45.5 <sup>1/</sup>	--

<sup>1/</sup> In tight bean bag by mistake instead of in more loosely woven potato bag

Table 2. Influence of method and length of exposure on browning and scald spots of Irish Cobbler potatoes, Gilcrest, Colorado August 11, 1942 - Inspected August 14

Method of exposure	Length of exposure Min.	Browning and scald spots on skinned areas		
		Dug 10:00 a.m. Percent	Dug 1:15 p.m. Percent	Dug 4:00 p.m. Percent
--	0	0	0	0
Spread out	15	0	0	2.5
Do	30	1.9	3.2	13.3
Do	60	14.6	83.2	96.6
In sacks				
•(potato burlap)	60	8.7	5.8	4.2
Do	120	5.3	21.4	34.8
Do	240	17.0	46.3	16.1 <sup>1/</sup>

<sup>1/</sup> Left in field overnight

Dug 6:15, left overnight, spread out . . . . . 23.7% browning

Dug 6:15, left overnight in sack . . . . . 16.2% "



Shortage of burlap bags, which have been the standard containers for potatoes, made it desirable to test various types of cotton bags now available for shipping potatoes. Six types were tested in one shipment. The detailed inspection notes may be found in Colorado shipping test No. 2, table 22. These data give some idea as to the durability of the bags, their appearance, and the loss in weight of the potatoes during transit. There were no significant differences in development of decay that could be associated with the type of bag used. However, some differences in bruising and other mechanical injuries were evident. The coarse-mesh or net bag always injured more of the outside tubers because the coarse threads made imprints on the tubers and frequently cut them where bags were against the side wall or the floor racks. Many of the dealers on the Chicago market objected to this bag on that account. However, some buyers were interested in the use of this bag because the potatoes could be seen without opening the bag. This bag is not desirable for shipping immature white potatoes since the light admitted through the coarse mesh would cause the potatoes to green during handling and while on display.

One of the chief objections to the cotton sheeting bags was that they showed water and soil spots so readily. It is impossible to load washed potatoes into white sacks without some spotting. Since the spotting of bags is considered by the trade as an indication of decay, the excessive spotting of the white sheeting bags creates an unfavorable impression. It would seem desirable to color the fabric or possibly use unbleached material.

The Victory cloth bag was colored light brown and this seemed to be a serviceable color from the standpoint of showing spots. This bag was also easily handled and seemed quite durable. It was perhaps second best to the burlap. The Osnaburg bag had a somewhat coarser mesh than the sheeting, but not so coarse as Victory cloth. It compared favorably with the Victory cloth; however, because of the white color of the Osnaburg, spotting was more evident. There was not much difference in the amount of weight lost by the tubers in the various types of bags. Potatoes in net bags lost slightly more than those in any of the others, and those in the waterproof sheeting bag lost slightly less. The latter bag was treated to test whether water and soil spots could be controlled by waterproofing, but from the few tests made this treatment seemed ineffective.

#### RESULTS OBTAINED IN TEST SHIPMENTS OF NEBRASKA POTATOES

Test No. 1, July 15, 1942

This test comprised two cars of potatoes of the Red Warba variety, one of which (PFE 94111) was shipped from Gibbon, Nebraska, the other (PFE 91201) from Shelton, Nebraska. All of the test lots and the load in one car (94111) were in 100-pound cotton-sheeting bags. The load in car 91201 was in 100-pound burlap bags. The object of the test was a comparison between pre-cooling and preicing. The loading in this test and in all other Nebraska shipments, unless otherwise specified, was of the pyramid type (5-3-2-1). In this load each stack is made up of five bags in upright position for the first layer, three bags crosswise for the second layer, two bags crosswise for the third layer and one bag crosswise for the fourth layer.



At loading time no decay was apparent in the test bags of potatoes, but 9 percent showed slight browning and 8 percent showed bruising.

Car PFE 94111 (300 bags) received mechanical precooling service for two hours and was then shipped with vents closed to Galesburg and open beyond. On arrival (July 18) the potatoes in this car had an average temperature of 81° F. The tubers were dry and firm, but, as shown in table 3, this lot had about twice as much decay and browning as the preiced car of similar stock shipped on the same date (July 15).

Car PFE 91201 (300 bags) was preiced to capacity (10,500 lbs.) and reiced at Galesburg with 9,100 lbs. The vents were kept closed to destination. This car arrived (July 18) showing an average temperature of 53°. About 3,200 lbs. of ice remained in each bunker. The tubers were moist as a result of condensation of moisture upon the cool potatoes when the car door was opened. There was an average of 7 percent decay in bags A, B, and C on arrival and 20 percent after one week's storage. The decay was bacterial soft rot, mostly the sticky type that develops on skinned, browned or scald-spot areas. The marked increase in the development of decay in these potatoes during storage was partly due to the fact that they were still wet from condensed atmospheric moisture when stored. Generally this moisture disappears soon after unloading, but in this instance conditions were unfavorable for drying and the tubers remained wet long enough to favor the development of decay.

Table 3. Condition of potatoes in Nebraska test shipment No. 1 upon arrival at Chicago and after one week storage

PFE 1/ car No. and shipping point	Type of shipment	Date inspected	Decay			DAMAGE			Scald spot			Loss in weight in transit		
			A	B	C 2/	A	B	C	A	B	C	A	B	C
			Percent			Percent			Percent			pounds		
94111	Precooled	July 18	13	14	19	11	11	18	0	0	0	1.3	.5	3.0
Gibson		July 25	24	19	35	13	19	17	0	0	0			
91201	Preiced &	July 18	5	7	10	4	5	9	0	0	0	1.2	1.8	1.4
Shelton	reiced	July 25	25	23	11	11	10	9	0	0	0			

1/ PFE Pacific Fruit Express Co.

2/ A, bag A, bottom bunker; B, bag B, middle layer quarterlength; C, bag C, top layer doorway.

Table 4. Temperatures in test bags during transit, Nebraska test shipment No. 1

PFE car No.	Bag	0 hrs.	12 hrs.	24 hrs.	36 hrs.	48 hrs.	60 hrs.
94111	A	Thermograph stopped -					
	B	84	78	78	79	80	81
	C	85	62	71	77	81	82
91201	A	80	60	53	53	47	46
	B	83	69	64	62	58	54
	C	87	73	68	66	62	59

Test No. 2, July 16, 1942

This test comprised two cars of potatoes of the Red Warba variety shipped from Buda, Nebraska. All of the test lots, all of the load in one car (PFE 51248), and part of the load in the other car (PFE 23838) were in 100-pound cotton-sheeting bags. Most of the load in car 23838 was in burlap bags. The object of the test was a comparison of preicing only, with preicing and one reicing in transit. The test lots showed no decay but had about 20 percent of slight browning at loading time. At loading time the air temperature was 100°F.

Car PFE 23838 (300 bags) was preiced to capacity at Grand Island, and the bunkers were still three-fourths full when the car was loaded. The vents were closed to destination. On arrival, July 20, the bunkers were dry. The average temperature of the potatoes at unloading time was 68°F. There was an average of 20 percent of bacterial soft rot in the three test bags on arrival. This unusual amount of decay reflects the effects of the excessive browning and the 100° temperature at loading time. The decay was primarily in the skinned brown areas and "scald spots." After storage for one week the test potatoes had 30 percent of bacterial soft rot, mostly of the sticky type over the "scald spots." Some surface mold (*Fusarium*) was present on a few specimens.

Car PFE 51248 (300 bags) was preiced to capacity and reiced at Council Bluffs and was shipped with the vents closed to destination. This car was diverted to Pittsburg, consequently no records on development of decay were obtained.

Potato condition and temperatures observed in this test are shown in tables 5 and 6.

Table 5. Condition of potatoes in Nebraska test shipment No. 2 upon arrival at Chicago and after one week in storage

PFE car No. and shipping point	Type of shipment	Date inspected	Decay			DAMAGE Browning			Scald spot			Loss in weight in transit		
			A	B	C	A	B	C	A	B	C	A	B	C
			Percent			Percent			Percent			Pounds		
23838 Buda	Preiced	July 20	20	32	10	8	5	3	0	0	0	.4	.2	.3
		July 27	31	35	23	10	10	4	0	0	0			

Table 5. Temperatures recorded in test bags during transit, Nebraska test shipment No. 2

PFE car		0 hrs.	12 hrs.	24 hrs.	36 hrs.	48 hrs.	60 hrs.	72 hrs.	84 hrs.
No.	Bag								
23838	A	84	63	54	54	54	56	59	65
	B	79	72	67	64	63	63	64	67
	C	83	74	70	68	68	68	69	73
51248	A	80	63	53	47	44	45	41	40
	B	80	70	63	58	55	52	51	50
	C	80	72	67	60	54	50	48	46

Test No. 3, July 17, 1942

This test comprised three cars (PFE 71569, 73981, and 44877) of potatoes of the Red Warba variety, shipped from Bula, Nebraska in 100-pound burlap bags. The object of the test was to obtain information on loss in weight of potatoes in transit. Eight 100-pound burlap bags of potatoes in the middle and top doorway of each car were tagged and weighed at shipping point. On arrival, July 20, each bag was reweighed to determine the loss in weight during transit. Each car contained 500 bags.

Car PFE 71569 (Preiced). Loading was finished at noon and the test bags were weighed at 3:30 p.m. On arrival in Chicago the average loss in weight in these eight bags was 1.6 lbs. per bag.

Car PFE 73981 (Preiced). Loading was finished at 5:30 p.m. The eight test bags were weighed at 9 p.m. On reweighing at Chicago it was found that the average loss per bag was 1.3 lbs.

Car PFE 44877 (Precooled two and one-fourth hours). Loading was finished at 6:45 p.m. The eight test bags were weighed at 6:30 p.m. On arrival these bags showed an average loss of 1.2 lbs. per bag.

From these data on twenty-four test bags of potatoes it is apparent that there was no significant difference in the loss of weight between the preiced and the precooled cars of potatoes. The car in which loss in weight was greatest happened to be loaded at noon whereas the others were loaded in late afternoon, but it appears doubtful whether the loading time was a factor in this test. Just how much of the loss in weight was due to the drying of moisture that was on the surface of the potatoes when they were loaded, was not determined.

Test No. 4, July 21, 1942

This test comprised three cars of potatoes of the Red Warba variety packed in 100-pound Osnaburg bags. Two cars (PFE 76085 and 45310) were shipped from Grand Island, Nebraska, and one car (PFE 71662) from Gibbon, Nebraska. The object of the test was a comparison between preicing and precooling and between cars with and without floor fans. No decay or browning was noted at loading point in the potatoes used in the test bags.



Car PFE 76085 (300 bags) was equipped with built-in floor fans at each end of the car. This car was preiced (3 tons) and the fans were run by an electric motor for five hours after loading was completed. In this time the average temperature of the load dropped from 69° to 60°. Electrical resistance thermometers placed at twelve different locations in the load were used to determine the temperature at shipping point, Council Bluffs, Galesburg, and Chicago. These temperature records are shown in Table 7. After leaving Grand Island the fans were operated in transit by belt and pulley from a friction drive wheel in connection with the car wheel. The vents were closed and the fans kept running until the car reached Galesburg. From Galesburg to destination the fans were not operated and the vents were open.

On arrival at Chicago, July 24, the vents were open and the bunkers dry. The average temperature of the load was 55° F. From table 8 it will be seen that there was less than 1 percent decay and no browning in the potatoes in the test bags. After one week storage there was 5 percent decay following bruises and about 5 percent browning. Bag A, which received more air circulation from the floor fans, showed slightly more browning of the tubers than bags B and C.

Car PFE 71562 (300 bags) was preiced to capacity but not reiced in transit. The vents were closed to destination. At the time of loading, these potatoes showed a temperature ranging from 60° to 70° F. On arrival at Chicago, July 25, the average temperature of the load was 51° F. About 100 pounds of ice remained in each bunker. These potatoes arrived in good, firm condition and had only 1 percent decay. After one week storage there was an average of 9 percent bacterial soft rot mostly following bruises.

The excessive loss of weight in this car (table 8) was believed to be due to the fact that the test bags were loaded a day previous to shipment, and the car arrived in Chicago a day late. Two or three tubers were lost out of bag B during handling.

Car PFE 45310 (300 bags) was mechanically precooled for two and one-half hours and billed "vents closed to Galesburg, open beyond." The average temperature of the potatoes at loading time was 74°, and after precooling 67° F. On arrival, July 24, the load averaged 68.5°. Two percent decay was found on arrival inspection. After one week storage the tubers were still firm and in good condition and showed an average of four percent decay.

Although not enough decay developed in car 76085 (fan-equipped) or car 45310 (precooled) to indicate any significant differences in the carrying quality of the potatoes in the two cars, a study of the temperatures in table 7 reveals some interesting features. In the two and one-half hours during which car 45310 received mechanical precooling the average temperature of the load dropped 7°. The precooling obtained in car 76085 by preicing it with three tons of ice and running the floor fans with an outside motor for the same length of time (melting 1400 lbs. of ice) reduced the average temperature of the potatoes 5°. The cost for mechanically precooling car 45310 was \$25. The

ice and bunker service charges for car 76085 were \$22. From the standpoint of precooling, there was little difference in the cost of servicing these two cars. However, the temperature differences between the two cars during transit became quite marked. The mechanically precooled car immediately began to warm up during transit, whereas the fan-equipped car still contained 4600 lbs. of ice and continued to become colder until it reached Galesburg, where the vents were opened and the fans were stopped. On arrival in Chicago, the average temperature of the potatoes was 13° lower in the fan-equipped car than in the precooled car. This difference in the temperature might well mean the difference between profit and loss in some shipments of potatoes.

Test No. 5, July 22, 1942

This test comprised two cars (PFE 32156 and 37919) of potatoes of the Red Warba variety, packed in 100-pound burlap bags. The cars were shipped from Gibbon, Nebraska. The object of the test was a comparison of a standard 300-bag load with a heavy 397-bag load.

Car PFE 32156 was loaded in regular pyramid style (5-3-2-1) with 300 bags. The potatoes in the test bags showed 2 percent browning and 1 percent decay at loading time. The car was preiced to capacity and reiced in transit. On arrival in Chicago, July 25, the bunkers were three-fourths full of ice and the commodity temperature averaged 49°F. Almost 2 percent bacterial soft rot was found at inspection on arrival and 5 percent after one week storage.

Car PFE 37919 was shipped under the same conditions, but the load was pyramid style (5-3-5-2-1-) making a load of 397 bags. On arrival, July 25, the bunkers were one-half full of ice and the commodity temperature averaged 45°F. Less than 1 percent decay was found on arrival and 6 percent after one week storage. So far as could be observed there was little difference in the development of decay in these loads. There was more bruising in the regular 300-bag load on arrival, but at the end of the week's storage the potatoes from the heavy load showed more bruising damage. The test bags in these cars were not in their usual position. All were placed in the doorway, (A) being in the bottom layer, (B) middle layer, and (C) top layer. Because of this distribution of the bags it seems unlikely that the higher percentage of bruising in the heavy load after one week storage could be attributed to the added weight of this type of load. On general inspection of the commercial part of the heavy load the bottom-layer bags did not show much more than the usual amount of bruising for standard loads.

Table 7. Potato temperatures during precooling, in transit, and on arrival. 1/  
Nebraska Test No. 4

PFE CAR No.	Inspection point	Date	Time	Out-side Temp.	1	2	3	4	5	6	7	8	9	10	11	12	Average	
75085 3/ Preiced Fan car	Grand Is.	7/21	2:45 p.m.	78	71.0	66.0	67.5	70.5	69.0	69.0	72.5	73.5	67.5	68.5	69.5	65.5	69.2	
			5:15 p.m.	80	66.5	59.0	62.5	63.0	67.5	62.5	66.5	67.5	67.5	67.5	63.5	62.5	63.0	64
			7:45 p.m.	82	61.0	53.0	58.5	58.5	64.5	57.0	61.5	62.5	62.5	66.0	58.0	58.0	59.0	59.8
			11:15 a.m.	74	53.4	49.0	54.9	53.0	56.4	50.7	55.3	56.3	56.3	56.6	52.0	55.7	55.6	54.1
45310 4/ Precooled	Galesburg	7/23	1:00 p.m.	79	49.9	47.0	49.4	48.0	52.4	47.7	49.8	49.3	52.1	48.5	51.2	50.1	49.6	
	Chicago	7/24	7:15 a.m.	64	55.9	57.5	53.9	57.9	53.4	52.7	51.8	58.8	53.1	52.0	51.7	60.6	55	
	Grand Is.	7/21	10:50 p.m.	72	69.5	67.5	70.0	68.5	71.0	79.0	77.5	77.0	78.5	76.0	74.5	75.5	74	
Co.Bluffs Chicago		7/22	1:20 a.m.	66	68.0	65.0	61.5	62.0	70.0	75.5	71.0	75.0	66.5	72.5	57.0	61.0	67	
		7/22	11:15 a.m.	74	66.5	63.0	61.5	63.2	68.2	69.9	69.8	71.2	64.9	68.0	67.8	62.4	66.5	
		7/24	7:30 a.m.	64	68.5	66.5	68.0	69.2	68.7	68.9	70.3	71.2	66.4	68.5	66.3	69.4	68.5	

-12-

1/ Temperature readings were taken by means of electric resistance thermometers.

2/ Location of bulbs in cars having resistance thermometers; all bulbs were placed in the center of the sacks of potatoes:

At bunker		At quarterlength		At doorway			
Bulb	#	1st layer	center row	Bulb	#	1st layer	center row
"	#2	1st layer	outside row	"	"	#10	1st layer
"	#3	2nd layer	center row	"	"	#11	2nd layer
"	#4	4th layer	center row	"	"	#12	4th layer

3/ Average temperature of load 69° F. at start of precooling (2:45 p.m.). After two and one-half hours (5:15) the average temperature was 64° . At end of five hours precooling by fan (7:45) the average temperature was 59.8°.

4/ Average temperature of load 74° F. at start of precooling (10:50 p.m.). At end of precooling (1:20 a.m.) two and one-half hours, the average temperature was 67°.



Table 8. Condition of potatoes in Nebraska test shipment No. 4 upon arrival at Chicago and after one week in storage

PFE car No. and shipping point	Type of shipment	Date inspected	DAMAGE									Loss in weight in transit		
			Decay			Browning			Scald spot					
			A	B	C	A	B	C	A	B	C	A	B	C
			Percent			Percent			Percent			Pounds		
76085	Preiced (3T)	July 24	1	0	1	0	0	0	0	0	0	1.1	.3	1.1
Grand Is.	Floor fans	July 31	4	4	8	7	4	3	0	0	0			
71562	Preiced to	July 25	2	1	1	0	1	3	0	0	0	2.1	4.3	1.9
Gibbon	capacity	Aug. 1	8	6	12	4	3	4	0	0	0			
45310	Precooled	July 24	4	2	1	0	0	0	0	0	0	1.0	1.0	1.1
Grand Is.		July 31	3	4	4	2	1	4	0	0	0			

Table 9. Temperature recorded in test bags during transit, Nebraska test shipment No. 4.

PFE car No.	Bag	0 hrs.	12 hrs.	24 hrs.	36 hrs.	48 hrs.	60 hrs.	72 hrs.	84 hrs.
76085	A	72	56	49	48	47	51	52	
	B	71	60	64	54	50	49	50	
	C	70	61	57	54	51	58	61	
71562	A	68	58	46	42	41	42	42	44
	B	68	63	58	54	53	52	52	52
	C	70	60	57	61	61	60	58	58
45310	A	70	65	65	66	68	68		
	B	70	70	70	70	70	70		
	C	70	58	63	67	68	69		

Table 10. Condition of potatoes in Nebraska test shipment No. 5 upon arrival at Chicago and after one week in storage

PFE car No. and shipping point	Type of shipment	Date inspected	DAMAGE									Weight loss		
			Decay			Browning			Scald spot			in transit		
			A	B	C	A	B	C	A	B	C	A	B	C
37919	Preiced	July 25	Percent			Percent			Percent			Pounds		
Gibbon	397 bags	Aug. 1	1	0	0	1	1	2	0	0	0	.8	.4	.9
			5	8	4	3	2	4	0	0	0			
32156	Preiced	July 25	Percent			Percent			Percent			Pounds		
Gibbon	300 bags	Aug. 1	3	2	0	1	2	1	0	0	0	2.0	.7	1.2
			4	6	4	8	6	11	0	0	0			

Table 11. Temperature recorded in test bags during transit, Nebraska test shipment No. 5

PFE Car							
No.	Bag	0 hrs.	12 hrs.	24 hrs.	36 hrs.	48 hrs.	60 hrs.
37919	A	80	51	44	42	42	42
	B	80	58	50	48	46	48
	C	80	64	52	48	46	46
32156	A	80	53	50	49	46	46
	B	82	59	56	50	50	48
	C	80	63	57	55	53	52

Test No. 6, July 24, 1942

This test comprised three cars of potatoes packed in 100-pound burlap bags. The load in car PFE 52522 consisted of Cobblers; in cars PFE 93095 and 76155, of Red Warbas. The test lots in all three cars were Eliss Triumphs. Car 52522 was shipped from Wood River, Nebraska. The other two from Gibbon, Nebraska. The object of the test was to compare (1) precooling with preicing and one reicing in transit with (2) cars with and without floor fans. The potatoes used in the test bags showed no decay or browning at loading time.

Car PFE 93095 (300 bags) was preiced to capacity and reiced at Galesburg and the vents were kept closed to destination. The average commodity temperature on arrival, July 27, was 43° F. The bunkers were about two-thirds full of ice. Only 1 percent bacterial soft rot was found on arrival and 2 percent after one week storage. Many tubers were slightly brown in the skinned areas.

Car PFE 52522 (300 bags) received mechanical precooling for 2 hours forty-five minutes. The average temperature of the load at the start of precooling was 71° and at the end of precooling it was 57° F. (table 12). This car was shipped with the vents closed to Galesburg and standard ventilation beyond. The average temperature of this load on arrival, July 27, was 71°. There was 3 percent soft rot on arrival and 5 percent after one week storage.

Car PFE 76155 (300 bags) was preiced to capacity and reiced at Galesburg; vents closed to destination. The floor fans were operating to Galesburg but disconnected beyond. The bunkers were about three-fourths full of ice on arrival, July 27, and the average temperature of the load was 44° F. There was an average of 1 percent decay on arrival and 3 percent after one week storage.

A detailed comparison of the temperatures obtained in the three methods of shipping may be obtained by a study of table 12.

Table 12. Potato temperatures during precooling, in transit and on arrival at Chicago  
Nebraska test No. 6

PFE car Inspec- tion No.	Date	Time	Out- side Temp.	Bulb numbers 1/							Aver- age						
				1	2	3	4	5	6	7		8	9	10	11	12	
52522	Wood Riv.	7/24	3 p.m.	90	75.5	71.0	64.0	76.0	71.0	68.5	70.0	70.5	73.0	72.5	69.5	77.5	71.
Precooled	Grand Is.	5:45 p.m.	88	69.5	59.0	59.5	49.0	71.5	65.0	60.5	63.0	43.0	60.0	44.0	44.5	57.	
		2 a.m.	72	68.0	58.5	61.5	64.5	69.0	67.0	65.0	66.5	56.0	58.5	55.0	66.0	63.	
		8:55 p.m.	68	66.3	63.3	63.7	65.4	67.5	65.3	65.3	67.2	-	60.8	61.6	66.0	65.	
		12:20 p.m.	85	67.8	68.3	67.7	68.4	68.5	67.8	67.8	69.7	-	66.3	67.6	69.0	68.	
		7:00 a.m.	72	71.3	72.8	70.7	71.1	71.0	71.8	69.3	72.2	-	70.3	70.1	72.0	71.	
76155	Gibbon	7/24	4:00 p.m.	92	69.5	71.5	72.0	73.0	73.5	74.5	74.5	75.0	74.5	75.0	72.5	73.	
Preiced fan car	Grand Is.	7/25	2:00 a.m.	72	61.0	61.0	62.5	69.0	66.5	63.5	67.5	69.0	62.0	63.0	68.5	68.5	65.
		7/25	8:55 p.m.	68	54.3	52.7	49.4	57.1	61.6	54.8	56.0	55.0	56.3	55.5	59.7	59.2	56.
		7/26	12:10 p.m.	85	46.3	45.7	44.0	46.1	51.1	46.3	47.0	46.0	48.8	46.5	48.2	47.2	47.
		7/27	6:25 p.m.	72	42.8	42.7	41.4	42.6	48.1	43.3	45.0	43.0	46.3	45.0	44.2	43.2	44.
93095	Gibbon	7/24	4:00 p.m.	92	71.5	73.5	71.0	69.5	72.0	73.5	73.5	71.0	71.0	73.0	72.5	71.5	72.
Breiced	Grand Is.	7/25	2:00 a.m.	72	60.0	62.0	59.5	69.0	59.0	60.0	63.0	70.5	58.5	67.5	56.0	66.5	63.
		7/25	8:55 p.m.	68	53.2	53.6	55.1	63.5	54.0	54.3	58.0	67.7	54.1	52.0	51.5	60.8	56.
		7/27	7:15 p.m.	72	40.2	-	40.6	42.4	41.0	42.8	43.5	50.2	-	41.0	40.0	47.3	43.

1/ Location of bulbs same as given in Table 7.



Table 13. Conditions of potatoes in Nebraska test shipment No. 6 upon arrival at Chicago and after one week in storage

PFE car No. and shipping point	Type of shipment	Date inspected	Decay			DAMAGE Browning			Scald spot			Loss in weight in transit		
			A	B	C	A	B	C	A	B	C	A	B	C
			Percent			Percent			Percent			Pounds		
76155 Gibbon	Preiced	July 27	0	1	3	0	0	0	0	0	0	1.0	1.9	1.2
	Floor fans	Aug. 2	3	4	3	9	8	8	0	0	0			
52522 Wood Riv.	Precooled	July 27	4	4	2	0	0	0	0	0	0	1.5	.9	1.5
		Aug. 2	3	9	3	7	6	10	0	0	0			
93095 Gibbon	Preiced	July 27	0	2	2	0	0	0	0	0	0	1.7	1.1	1.8
		Aug. 2	1	4	0	4	10	4	0	0	0			

Table 14. Temperature recorded in test bags during transit, Nebraska test shipment No. 6

PFE car No.	Bag	0 hrs.	12 hrs.	24 hrs.	36 hrs.	48 hrs.	60 hrs.	72 hrs.
76155	B	72	67	59	55	48	44	46
52522	B	74	70	71	72	68	69	71
93095	B	70	60	54	50	46	42	42

Test No. 7, July 27, 1942

This test comprised three cars of potatoes, two of which were shipped from Grand Island, Nebraska and one from Gibbon, Nebraska. In car PFE 76470 the load was of Red Warbas in 100-pound Osnaburg bags; in PFE cars 73007 and 30044 it was of Cobblers in 100-pound burlap bags. All of the test lots were in 100-pound burlap bags. The object of the test was a comparison of preicing with precooling in cars with and without floor fans.

Car PFE 30044 (300 bags) was preiced and not reiced in transit, and shipped with vents closed to destination. The potatoes in the test bags showed no decay or browning at time of loading. On arrival, August 1, about 150 pounds of ice remained in each bunker. The average temperature of the load was 57° F. There was 5 percent of bacterial soft rot on first inspection and 20 percent after one week storage. The decay followed mechanical injury and wire worm injury.

Car PFE 76470 (360 bags) was preiced to capacity (11,500 lbs.) and was cooled by motor-operated floor fans for one hour and thirty minutes after loading and thereafter the fans were operated by the car wheels to Council Bluffs. From Council Bluffs to Chicago the fans were not operated. Temperatures observed in this car in transit are shown in table 15. On arrival, August 1, there was about 200 pounds of ice in each bunker and the average commodity temperature was 59°. There was 5 percent decay on arrival and 11 percent after one week storage. Although this car was loaded twenty percent heavier than the other two cars in the test it arrived in slightly better condition.

PFE

Car/73007 (300 bags) was precooled by mechanical refrigeration for two hours and thirty minutes and at Council Bluffs was stage-iced with two and one half tons of ice. The vents were closed to destination. This car arrived August 1, with about 10 pounds of ice in each bunker. The commodity temperature averaged 59° F. There was an average of 7 percent decay on arrival and 16 percent after one week storage. The decay was bacterial soft rot following mechanical injury and enlarged lenticels. The cost of precooling and icing this car was about \$45.00.

Test No. 8, August 5, 1942

This test comprised two cars of potatoes of the Red Warba variety, one of which (PFE 14792) was shipped from Buda, Nebraska, the other (PFE 97009) from Grand Island, Nebraska. The load in 14792 was of Red Warbas in 100-pound burlap bags; in 97009 it was of Red Warbas in 100-pound cotton-sheeting bags. All of the test lots were Cobblers, in 100-pound cotton-sheeting bags. The object of the test was a comparison of preicing with mechanical precooling. The potatoes in the test bags showed no decay or browning at loading time but about 3 percent of them had enlarged lenticels. Approximately 1 percent showed sunken areas that had not yet become brown.

Car PFE 97009 (300 bags) was mechanically precooled, and iced with one ton of ice per bunker at Clinton, Iowa. Precooling service two hours and thirty minutes. On arrival, August 8, there were 300 pounds of ice in each bunker and the average temperature of the load was 64°. There was an average of 19 percent decay on arrival and 37 percent after one week storage. In bag B, 65 percent of bacterial soft rot was found following enlarged lenticels and bruises after holding one week. Some tubers showed soft bleached spots with the epidermis intact, as if injured by scald. The cost of precooling and icing in transit was about the same as for preicing and reicing PFE 14792, but the arrival condition of the potatoes was not as satisfactory.

Car PFE 14792 (300 bags) was preiced to capacity and reiced at Council Bluffs. On arrival, August 8, the bunkers were about two-fifths full of ice and the commodity temperature averaged 45°. The arrival inspection showed 6 percent soft rot, and after one week storage 38 percent soft rot was found. The decay followed bruises and enlarged lenticels. In a few instances some Fusarium as a surface mold developed during storage. About half of the tubers in Bag B decayed in storage in the same manner as those in car 97009, table 18.

These Cobblers developed more decay than was found in any other lot used in test shipments, probably due to prevalence of the enlarged lenticels which were important avenues of infection. Furthermore, it appears that immature Cobblers stored moist or slightly wet do not keep as well as the Warba and Triumph varieties.

Table 15. Potato temperatures during precooling, in transit and on arrival at Chicago  
Nebraska test No. 7.

PFE car No.	Inspection point	Date	Time	Outside Temp.	Bulb No. 1/												Average
					1	2	3	4	5	6	7	8	9	10	11	12	
76470	Grand Is.	7/29	9 p.m.	76	65.0	-	71.0	73.0	72.0	72.0	-	78.5	72.5	72.5	-	-	72.
Preiced fan car	Co.Bluffs	7/30	10:30	72	64.0	-	68.0	71.0	70.5	70.5	64.0	73.5	73.0	71.5	-	-	70.
			9:50	78	54.0	-	56.1	59.2	63.2	60.0	58.4	59.6	66.1	62.2	67.5	-	60.6
			9:45	83	55.0	-	55.1	60.2	59.2	57.0	-	61.6	60.6	58.2	61.5	-	58.7
			6:45	75	56.5	-	54.6	61.2	57.7	56.0	60.4	64.6	58.1	57.7	60.0	-	58.7
	Chicago	8/1															

1/ Location of bulbs same as given in Table 7



Table 16. Condition of potatoes in Nebraska test shipment No. 7 upon arrival at Chicago and after one week in storage

PFE car No. and shipping point	Type of shipment	Date inspected	DAMAGE									Loss in weight		
			Decay			Browning			Scald spot			in transit		
			A	B	C	A	B	C	A	B	C	A	B	C
			Percent			Percent			Percent			Pounds		
76470														
Grand Is.	Preiced, floor fans	Aug. 1	5	8	3	0	0	0	0	0	0	1.2	.9	1.8
		Aug. 8	6	17	10	0	1	2	0	0	0			
30044	Preiced	Aug. 1	2	6	8	0	0	0	0	0	0	1.7	2.2	2.3
Gibbon		Aug. 8	13	23	25	2	2	10	0	0	0			
73007														
Grand Is.	Precooled and iced	Aug. 1	12	3	5	0	0	0	0	0	0	.8	1.2	1.4
		Aug. 8	18	17	15	1	2	2	0	0	0			

Table 17. Temperature recorded in test bags during transit, Nebraska test shipment No. 7

PFE car No.	Bag	0 hrs.	12 hrs.	24 hrs.	36 hrs.	48 hrs.	60 hrs.
30044	A	80	51	47	48	50	51
	B	78	65	60	56	58	58
	C	74	70	66	64	62	62
73007	A	78	70	68	58	55	54
	B	78	73	72	67	62	60
	C	80	69	71	69	65	64
76470	A	65	54	55	56	56	56
	B	72	58	58	59	60	60
	C	72	60	61	62	63	64

Table 18. Condition of potatoes in Nebraska test shipment No. 8 upon arrival at Chicago and after one week in storage

PFE car No. and shipping point	Type of shipment	Date inspected	DAMAGE								
			Decay			Browning			Scald spot		
			A	B	C	A	B	C	A	B	C
			Percent			Percent			Percent		
14792	Preiced	Aug. 8	4	7	7	0	0	0	0	0	0
Buda		Aug. 15	40	50	24	0	1	2	0	0	0
97009	Precooled	Aug. 8	10	31	15	0	0	1	0	0	0
Grand Is.	and iced	Aug. 15	15	65	32	2	3	2	0	0	0

Table 19. Temperature recorded in test bags during transit, Nebraska test shipment No.8

PFE car No.	Bag	0 hrs.	12 hrs.	24 hrs.	36 hrs.	48 hrs.	60 hrs.
14792	A	76	50	42	39	38	38
	B	78	65	56	51	48	46
	C	78	72	65	57	53	50
97009	A	78	73	72	74	68	62
	B	77	76	76	76	74	71
	C	76	64	69	72	64	60

# RESULTS OBTAINED IN COLORADO TEST SHIPMENTS.

Test No. 1, August 11, 1942

This test comprised two cars (PFE 19404 and 76205) of potatoes (360 bags each) of the Bliss Triumph variety packed in 100-pound burlap bags and shipped from Gilcrest, Colorado. The test lots were also Triumphs in 100-pound burlap bags. The object of the test was a comparison of (1) preicing with (2) ventilation during the first part of the transit period, followed by icing at North Platte. The bags were loaded vertically in the bottom layer, six bags across; the second and third layers were made up of bags loaded horizontally, three wide across the car. The potatoes in the test bags showed no decay or browning, but 20 percent had bruising and 18 percent had enlarged lenticels.

Car PFE 19404 was shipped with the vents open to North Platte and there iced to capacity, and vents closed to destination. On arrival, August 14, the bunkers were two-fifths full of ice and the commodity temperature averaged 50° F. There was 1 percent decay on arrival and 6 percent after one week storage. Most decay was bacterial soft rot following mechanical injury and enlarged lenticels. A few tubers showed Phytophthora (late blight) rot.

Car PFE 76205 was preiced to capacity at Denver and not reiced; the vents were closed to destination. On arrival, August 14, there was about 400 pounds of ice in bunker A and 150 pounds of ice in Bunker B. The commodity temperature averaged 53° F. There was 2 percent soft rot on arrival and 5 percent after one week storage. Most decay followed bruises and enlarged lenticels. Some Fusarium developed as a surface mold during storage.

Although this car was equipped with floor fans they were not used in this test.

Table 20. Condition of potatoes in Colorado test shipment No. 1 upon arrival at Chicago and after one week in storage

PFE car No. and shipping point	Type of shipment	Date inspected	Decay			DAMAGE			Scald spot			Loss in weight in transit			
			A	B	C	A	B	C	A	B	C	A	B	C	
Percent			Percent			Percent			Pounds						
19404															
Gilcrest, Colo.	Iced	Aug. 14	0	1	4	0	0	0	0	0	0	.9	.3	1.2	
		Aug. 21	8	6	4	3	5	1	0	0	0				
76205															
Gilcrest	"	Preiced	Aug. 14	3	2	2	0	0	1	0	0	0	.4	1.2	3.2
		Aug. 21	2	2	8	6	11	8	0	0	0				

Table 21. Temperature recorded in test bags during transit, Colorado test shipment No. 1

PFE Car No.	Bag	0 hrs.	12 hrs.	24 hrs.	36 hrs.	48 hrs.	60 hrs.	72 hrs.
19404	A	67	67	60	44	41	40	42
	B	63	64	67	64	58	53	50
	C	64	68	70	68	62	58	58
76205	A	64	52	50	50	50	50	
	B	64	70	57	50	51	52	
	C	64	70	62	60	60	58	

Test No. 2, August 12, 1942

The object of this test was a comparison of the condition of potatoes shipped in six different kinds of bags, all in one car (PFE 51901). The potatoes used were Bliss Triumphs that showed no decay or other defects except scab. The car was shipped from Gilcrest, Colorado.

Car PFE 51901 (360 bags) was shipped standard ventilation to North Platte and there iced to capacity. The vents were closed to destination. On arrival, August 15, the bunkers were two-fifths full of ice. The potatoes at the bottom doorway showed a temperature of 46° and at the top doorway 56° F. The "A" bags were at the bottom quarter length position, the "B" bags at the middle quarter-length, and the "C" bags at the top doorway. The detailed inspection data are shown in Table 22.

Table 22. Comparison of the condition of potatoes shipped in six different types of bags on arrival in Chicago and after one week storage. Colorado test No. 2

Type of bag	Date	DAMAGE								
		Decay			Browning			Bruises		
		A	B	C	A	B	C	A	B	C
		Percent			Percent			Percent		
								Pounds		
Cotton	8/15	0	0	1	0	0	0	9	3	11
mesh	8/22	5	4	1	0	0	1	11	16	10
Victory	8/15	0	0	2	0	0	0	5	3	12
cloth	8/22	3	2	2	0	3	0	7	9	9
Cotton	8/15	0	2	2	0	0	0	7	1	7
Osnaburg	8/22	3	5	2	0	0	0	8	3	5
Cotton	8/15	0	1	2	0	0	0	6	2	11
Sheeting	8/22	5	2	5	0	1	0	3	11	5
Burlap	8/15	0	1	3	0	0	0	5	0	9
	8/22	3	0	3	1	0	0	8	12	8
Waterproof	8/15	-	0	0	-	0	0	-	2	14
Sheeting	8/22	-	3	2	-	2	1	-	6	5

The potatoes in the cotton mesh bags usually showed slightly more scuffing and bruising of the outside tubers than that in any other type of bag. On arrival, this bag at the A position showed no holes, but the bottom tubers were scuffed and bruised. The B bag had three small holes worn through the fabric and many outside tubers showed bag prints and cuts. The C bag had two holes worn through and the outside tubers showed excessive feathering and scuffing.

The Victory cloth bags showed slight bruising of the outside tubers. The A bag had two small holes worn through the side. The B and C bags were entirely satisfactory and showed no serious bruising.



The Osnaburg bags were satisfactory at all three positions. No holes were found in any of them and the outside tubers were only slightly bruised. In the A bag, which apparently was more moist than the others, some staining caused by the brand ink was evident on the outside tubers.

The cotton-sheeting bags were generally satisfactory at each position, but more spotting was apparent than in any other type of bag. The bag at the C position had one hole worn through. The outside tubers at all positions showed slight bruising.

The burlap was the most satisfactory bag from all standpoints since there was less spotting, less serious bruising, and no holes were worn through at any position.

The waterproof-sheeting bag was little if any different from the regular sheeting bag; dirt and water spots were evident in both. One small hole was worn through on the side of the B bag, but only slight bruising was apparent. Weight loss was greatest in the cotton mesh bags, lowest in the sheeting bags and intermediate in the other three types.

Test No. 3, August 13, 1942

This test comprised two cars of potatoes (PFE 94687 and 76195) of the Bliss Triumph variety packed in 100-pound Osnaburg bags loaded 6-3-3 and shipped from Gilcrest, Colorado. The test lots were in 100-pound burlap bags. The object of the test was to investigate the effect of modified ventilation and icing in transit, in cars with and without floor fans. The potatoes in the test bags showed no decay, but had 6 percent bruising.

Car PFE 94687 (360 bags) was shipped with vents open to North Platte. It was then iced to capacity and the vents closed to destination. On arrival, August 17, the bunkers were two-fifths full of ice and the commodity temperature averaged 44°. The tubers were moist, firm and very crisp, many showing slight cracking. Arrival inspection showed 2 percent soft rot following mechanical injury and only 2 percent after one week storage.

Car PFE 76195 (360 bags) was shipped with vents open to North Platte. There the car was iced to capacity and the vents were closed. The floor fans were operated from North Platte to Omaha but were not operated from Omaha to destination. This car arrived with the bunkers one-fourth full of ice and an average commodity temperature of 46°. There was less than 1 percent decay on arrival and only about 2 percent after one week storage. The decay was bacterial soft rot in very early stages following bruises.

Table 23. Condition of potatoes in Colorado test shipment No. 3 upon arrival at Chicago and after one week in storage

PFE car No. and shipping point	Type of shipment	Date inspected	Decay			DAMAGE			Scald spot			Loss in weight in transit.		
			A	B	C	A	B	C	A	B	C	A	B	C
			Percent			Percent			Percent			Pounds		
94687 Gilcrest, Colo.	Iced	Aug. 17	0	4	6	0	0	0	0	0	0	.8	.7	1.1
		Aug. 24	1	2	2	0	0	0	0	0	0			
76195 Gilcrest, "Floor fans	Iced	Aug. 17	1	0	0	0	0	0	0	0	0	1.1	.4	2.2
		Aug. 24	1	-	4	1	-	0	0	0	0			

Table 24. Temperatures recorded in test bags during transit, Colorado test shipment No. 3

PFE car No.	Bag	0 hrs.	12 hrs.	24. hrs.	36 hrs.	48 hrs.	60 hrs.	72 hrs.	80 hrs.
94687	A	66	63	54	44	41	40	40	40
	B	64	64	59	53	49	48	44	44
	C	65	64	61	58	54	51	50	48
76195	A	64	64	52	46	42	40	40	40
	B	65	64	50	49	50	50	49	49
	C	70	63	54	50	52	52	52	50

Test No. 4, August 14, 1942

This test comprised two cars of potatoes (PFE 76466 and 76181) of the Bliss Triumph variety, packed in 100-pound Osnaburg bags, and shipped from Gilcrest, Colorado. The test lots were in 100-pound burlap bags. The object of the test was to investigate the effect of modified ventilation and icing in transit, in cars with and without floor fans. The potatoes in the test bags (burlap) showed no decay at loading time, but had 5 percent bruising and many tubers were blemished by deep-pitted scab.

Car PFE 76466 (360 bags) was shipped with vents open to North Platte and there iced to capacity and vents closed to destination. The floor fans were operated by motor for three hours, then by car wheel (fans in B end not operating on account of a pulley broken in transit) from Gilcrest to North Platte. The bunkers were one-half full of ice on arrival in Chicago, August 17. The average temperature of the load was 49° F. Less than 1 percent decay was found on arrival and 1 percent after one week storage. All decay was bacterial soft rot of the sticky type.

Car PFE 76181 (360 bags) was shipped with vents open to North Platte and iced to capacity, then the vents were closed to destination. The floor fans were operated from Gilcrest to Omaha. This car arrived, August 17, with the bunkers one-half full of ice and an average commodity temperature of 49° F. There was less than 1 percent decay on arrival and 3 percent after one week storage. The decay was bacterial soft rot following mechanical injury.

Table 25. Condition of potatoes in Colorado test shipment No. 4 upon arrival at Chicago and after one week in storage

PFE car No. and shipping point	Type of shipment	Date inspected	Decay			DAMAGE Browning			Scald spot			Loss in weight in transit		
			A	B	C	A	B	C	A	B	C	A	B	C
			Percent			Percent			Percent			Pounds		
76466	Iced	Aug. 17	0	1	1	0	0	0	0	0	0	.9	.9	1.7
Gilcrest, Colo.	Floor fans	Aug. 24	1	1	1	0	1	0	0	0	0			
76181	Iced	Aug. 17	0	1	0	0	0	0	0	0	0	.9	1.0	.2
Gilcrest, "	Floor fans	Aug. 24	2	2	5	1	0	0	-	-	-			

Table 26. Temperatures recorded in test bags during transit, Colorado test shipment No. 4

PFE car No.	Bag	0 hrs.	12 hrs.	24 hrs.	36 hrs.	48 hrs.	60 hrs.	72 hrs.
76466	A	64	62	54	46	42	41	42
	B	66	62	50	59	55	53	50
	C	66	61	60	59	57	54	56
76181	A	68	65	62	54	47	45	44
	B	68	62	62	60	45	47	50
	C	68	64	62	54	50	50	53

### SUMMARY AND CONCLUSIONS

Potatoes shipped from central Nebraska and Colorado during July and August carry best under refrigeration. Precooled shipments should prove satisfactory if the precooling is continued long enough to reduce the average temperature of the load in transit to between 55° and 60° F. So far as can be judged from the results of this year's work it appears that the average temperature of the load during transit need not be below 60° F. if the potatoes are of good quality and have been handled carefully.

The cooling of potatoes promptly after loading is one of the important factors in controlling development of decay during transit. When wet potatoes are loaded warm and remain warm for several hours injuries of any kind may provide entrance for decay-producing organisms. The good results obtained this year with shipments of potatoes in preiced and precooled cars shows the effectiveness of quick cooling of potatoes loaded during hot weather. Potatoes shipped in preiced cars showed less decay on arrival than those in comparable precooled cars which were iced in transit, although this difference was not apparent after one week holding.



From an economic standpoint it appears that preiced cars need not be reiced in transit (provided they were preiced the night before loading) if they are going no farther east than Chicago. (See the records of cars 23838, 71562, 76470, and 30044).

Potatoes loaded in preiced cars equipped with floor fans may be cooled satisfactorily while standing on track, by running the fans with motors. An even distribution of cool air throughout the load is obtained by this method. Furthermore the fans run from the car wheels during transit continue to force cold air through the load in such a manner as to lower the temperature of the potatoes at the top of the load to within a few degrees of the temperature at the bottom.

Potatoes shipped in preiced fan cars usually showed less decay on arrival than those in comparable preiced cars without fans, but after one week storage no difference was apparent.

In the Colorado test comparing preicing with delayed icing, tuber temperature was lowered more rapidly in preiced cars. However, delayed icing at North Platte was apparently entirely satisfactory in the tests run this season. In all three tests, the potato temperatures in this type of refrigeration never rose above 70° F.

As was found in the 1941 test shipments, the highest percentage of decay was generally found at the B position (middle quarterlength) and the least at the A position (bottom bunker).

Most of the decay found this year was bacterial soft rot following browning and scald spots. Since skinned and bruised areas on tubers are predisposed to bacterial soft rot by exposure to the drying effects of hot, dry air, or winds which cause the blemishes called browning and scald spots, it appears that protection of newly harvested potatoes against dry air and winds is one of the most important methods of reducing the probability of decay developing during transit.

Not enough tests were made to get much information of the effects of heavy loading. In the one comparison of a 300-bag load with a load of 397 bags, little difference could be noted. The condition of the tubers and the load temperatures were very similar. There was no excessive bruising or crushing of tubers in the bottom layer bags of the heavy load. The Colorado shipments of 360 bags arrived in a satisfactory condition and without serious bruising.

When cotton bags were used those having a slightly coarser mesh than the ordinary sheeting seemed preferable. The Victory cloth and Osaburg bags were of this type and they proved satisfactory this season. Bags that have enough color in them to mask ordinary water and soil spots make a better appearing load.

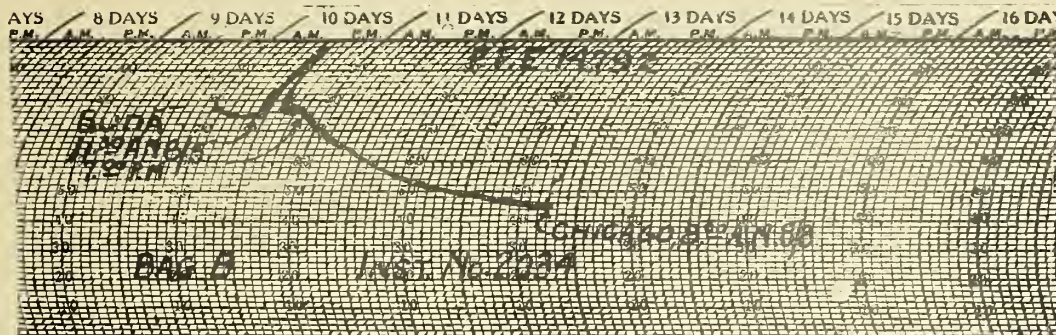
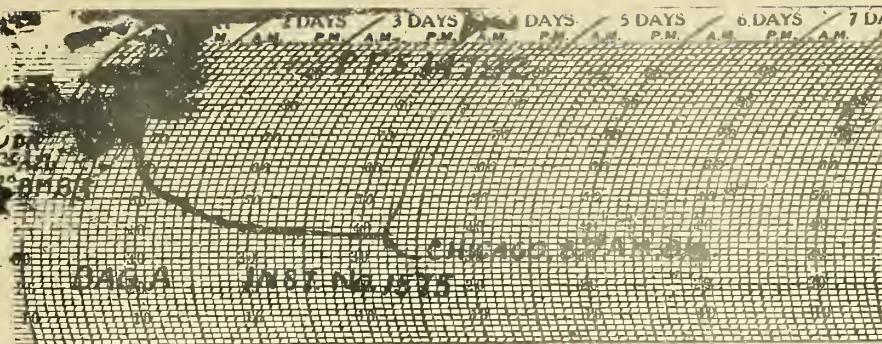
In checking the loss in weight of potatoes during transit in six different kinds of bags, no great differences were found. As might be expected the tubers in coarse-mesh or net bags lost most and those in cotton sheeting bags lost least.

In 99 bags for which records were obtained on loss in weight in transit, the average loss for all types of shipment was 1.2 pounds per bag or about 1.2 percent. In the four tests in which a direct comparison of loss in weight in transit was possible between preiced cars and precooled cars, the loss was always greater in the preiced cars. The potatoes in iced cars equipped with floor fans lost less weight than those in comparable cars without fans, in three out of four cases. This was probably because air leaving the ice was chilled by the ice to a temperature not much above 32 degrees and therefore was necessarily low in temperature and high in relative humidity. In the body of the car this air spread out over the top of the entire load and settled slowly providing conditions favorable for cooling but unfavorable for dehydration. From this it is apparent that floor fans would not cause excessive desiccation. Loss in weight in all types of shipments was generally highest at the C position, and slightly less at the B than at the A position.



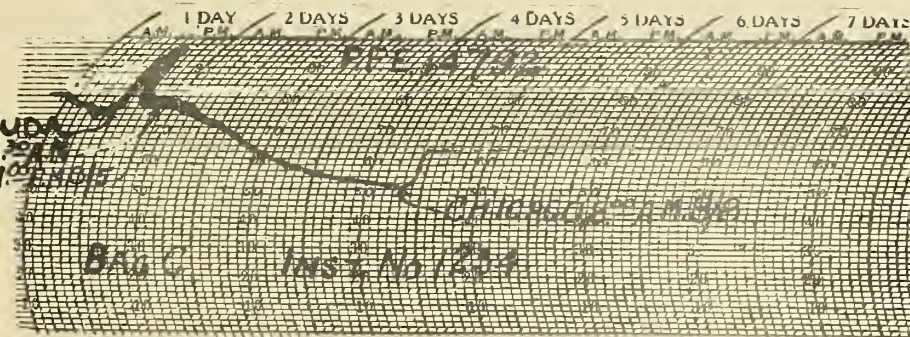
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Car  
RYAN RECORDING THERMOMETER CO.



Record No. 44101

Car  
RYAN RECORDING THERMOMETER CO.

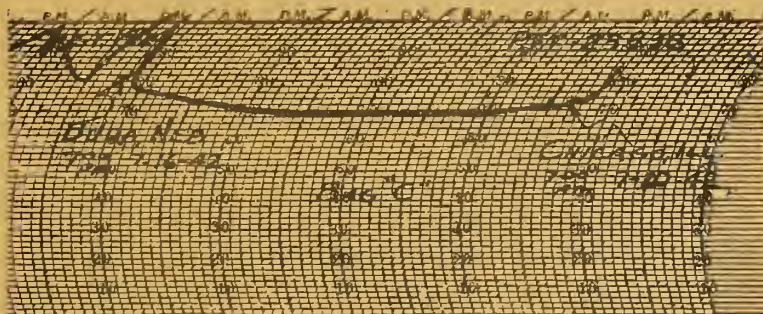
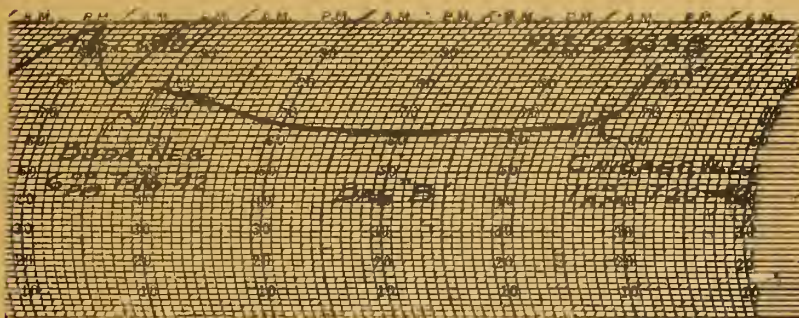
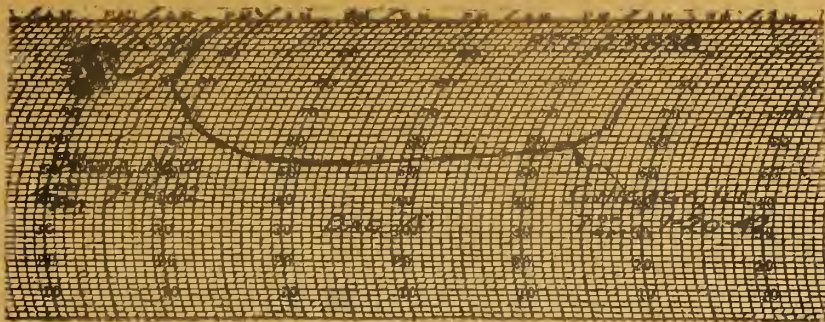


Nebraska 1942-8

PFE 14792 - 30,000-pound load. Priced to capacity and reiced at Council Bluffs. Vents closed to destination.





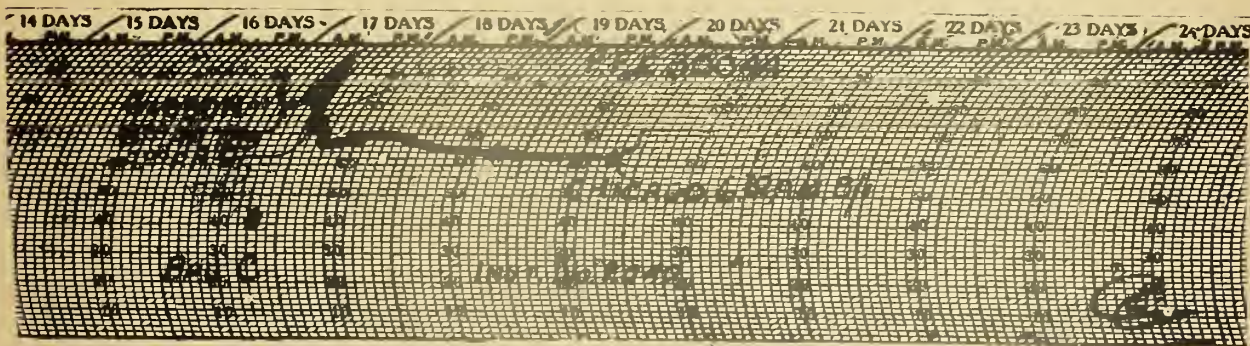
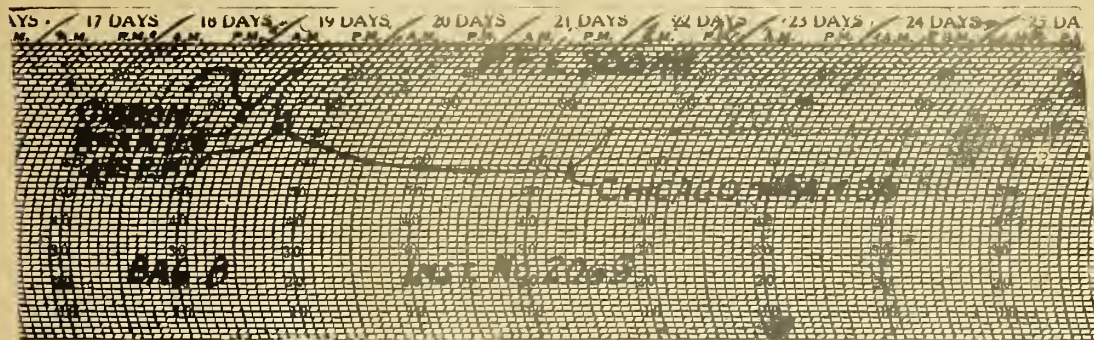
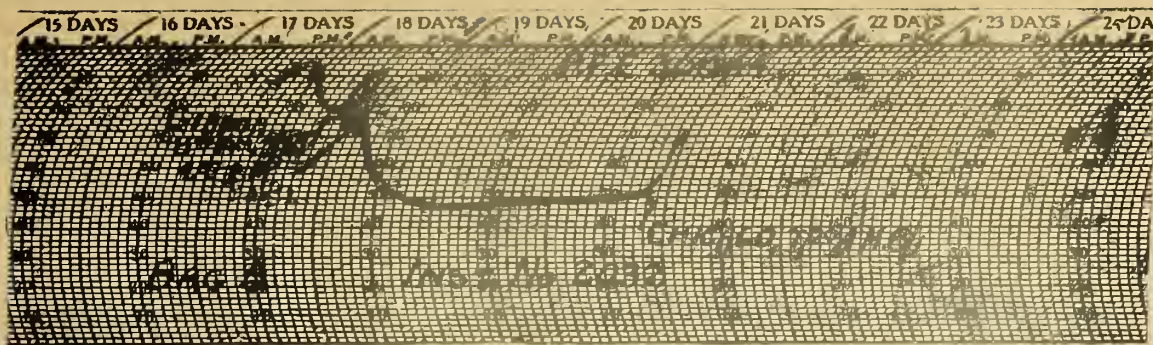


Nebraska 1942-2

PFE 23838 - 30,000-pound load. Preiced to capacity. Vents  
closed to destination.







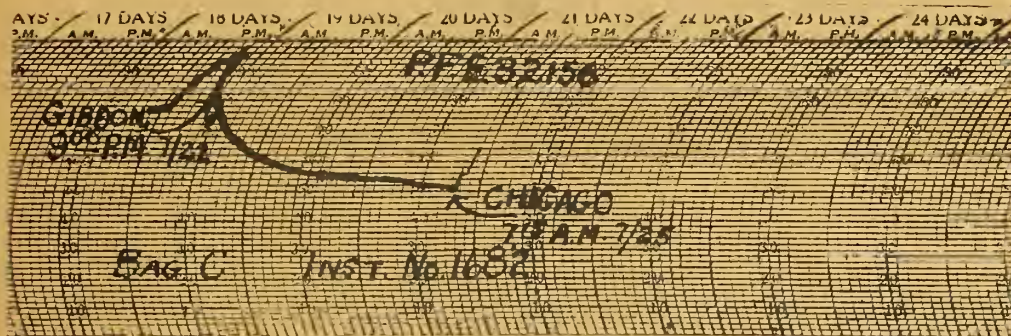
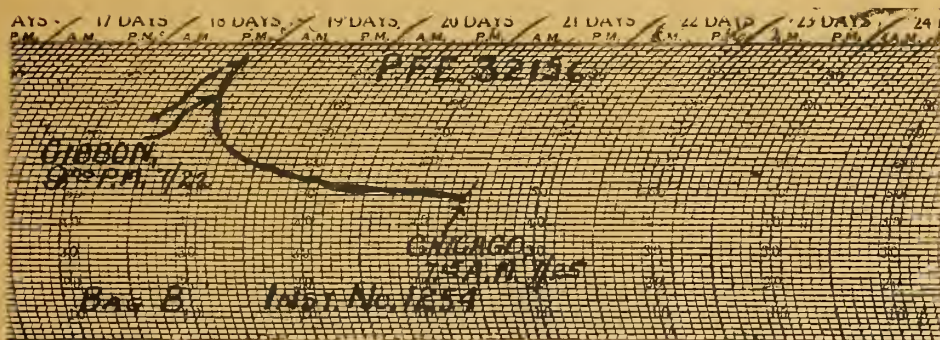
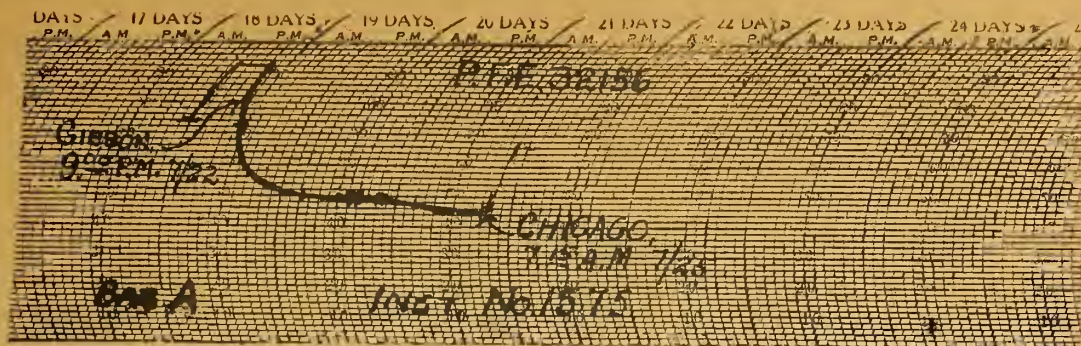
Nebraska 1942-7

PFE 30044 - 30,000-pound load. Preiced to capacity, not reiced.

Vents closed to destination.





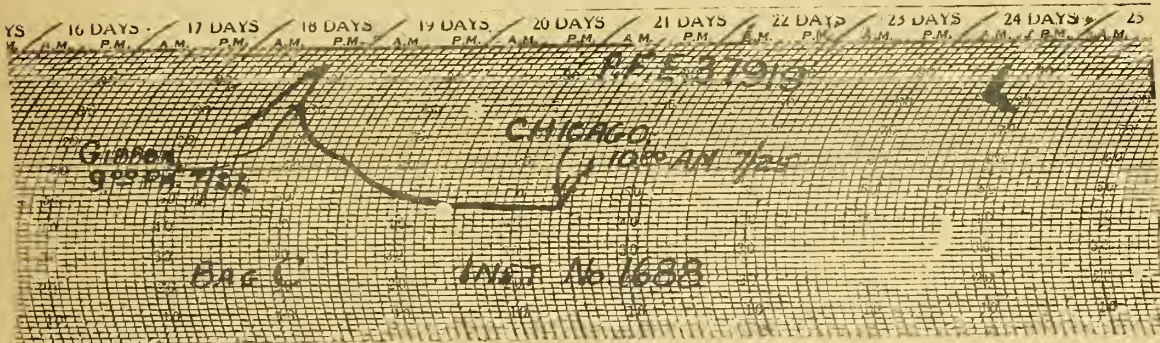
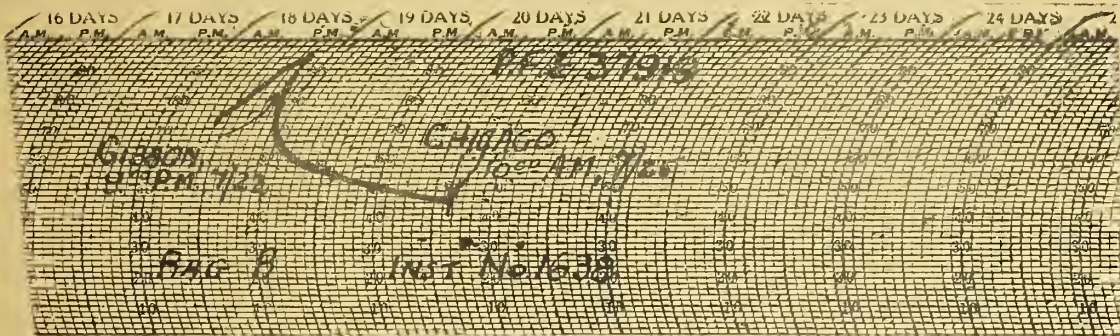
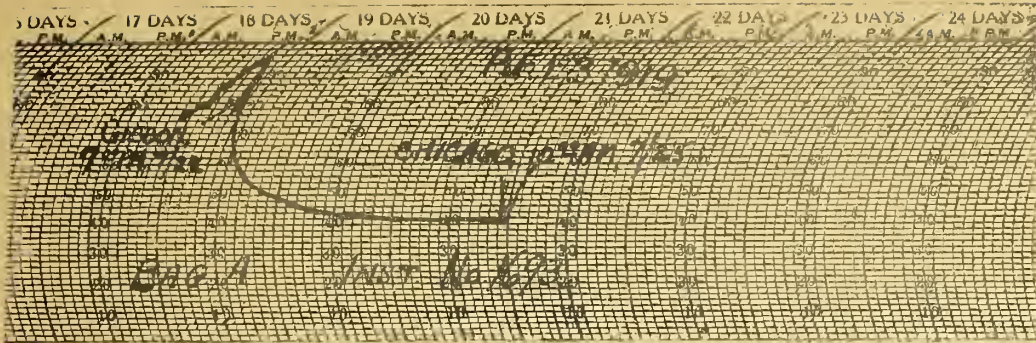


Nebraska 1942-5

PFE 32156 - 30,000-pound load. Priced to capacity and reiced at  
 Clinton, Iowa. Vents closed to destination.







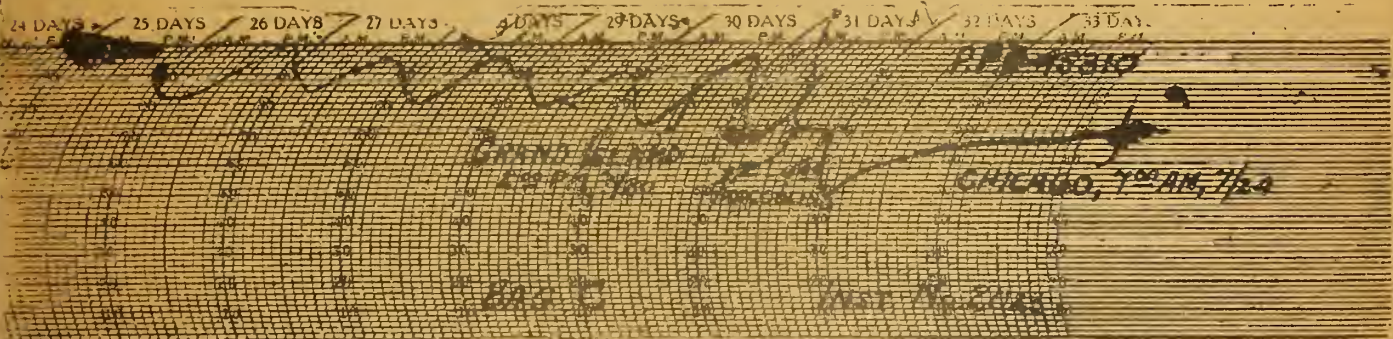
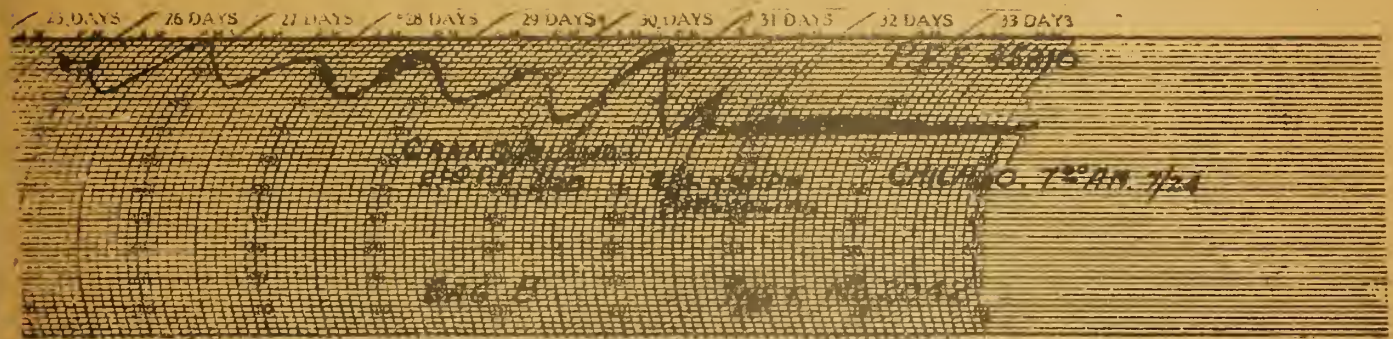
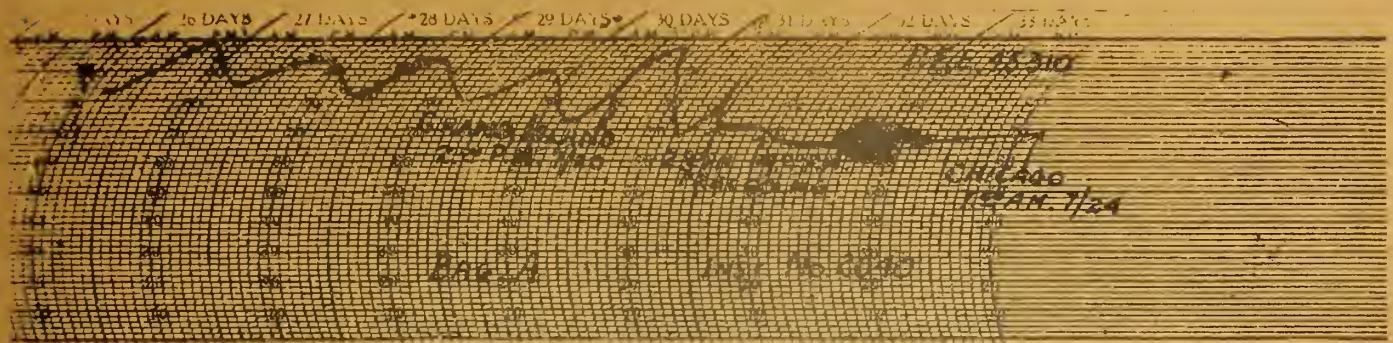
Nebraska 1942-5

PFE 37919 - 39,700-pound load. Preiced to capacity and reiced.

Vents closed to destination.





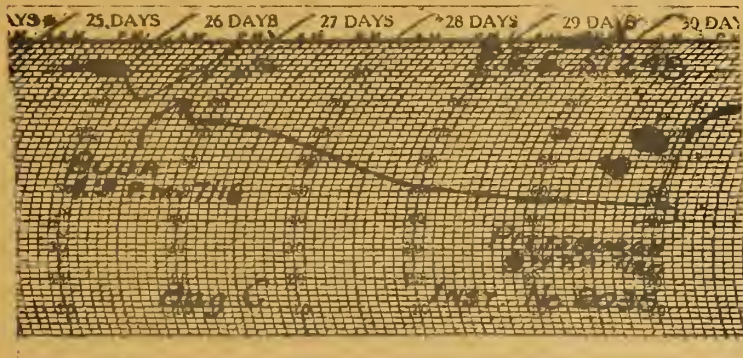
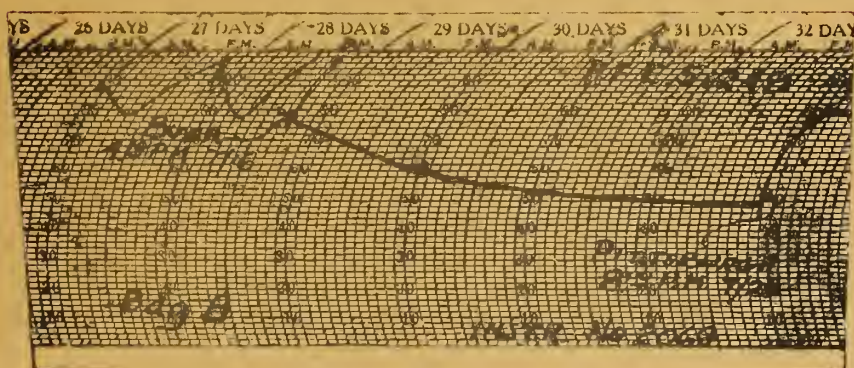
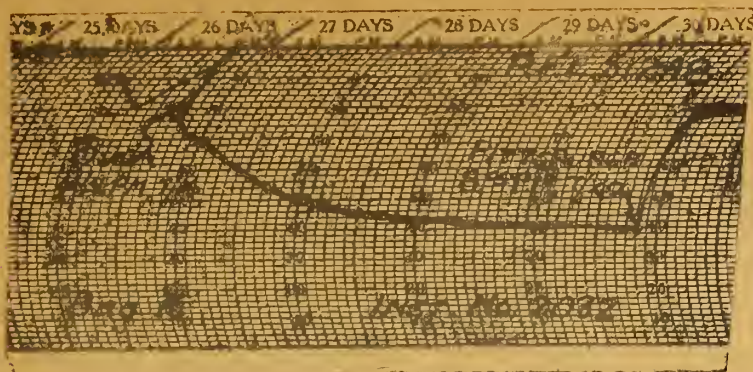


#### Nebraska 1942-4

PFE 45310 - 30,000-pound load. Precooled 2 hours, 40 minutes by Shippers' Precooling Service. Vents closed to Galesburg, open beyond.





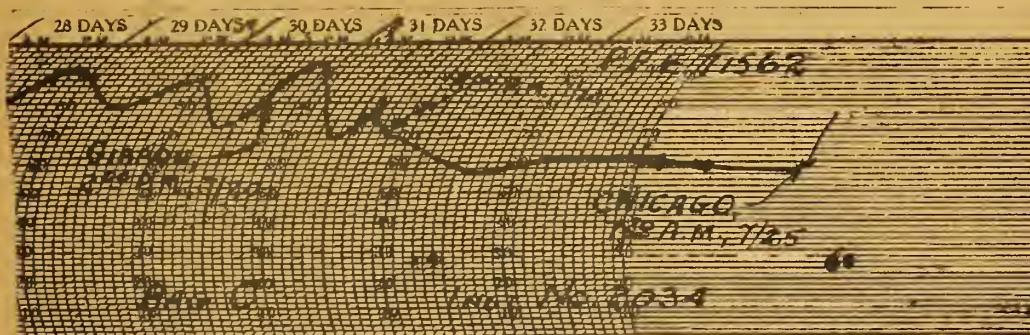
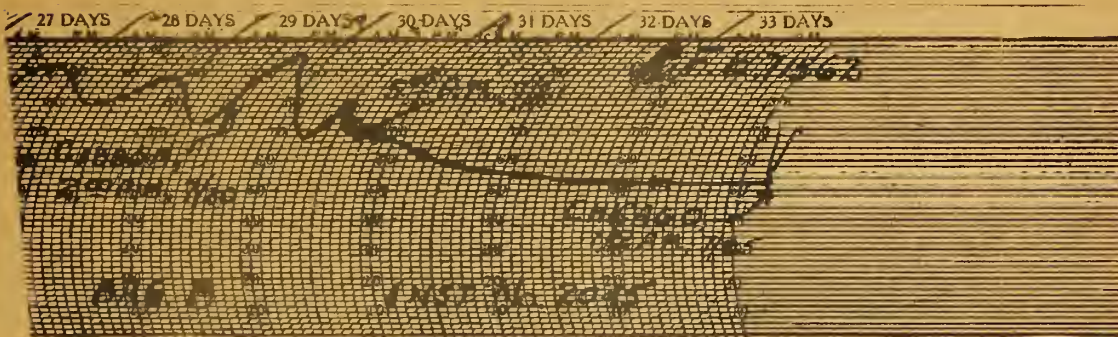
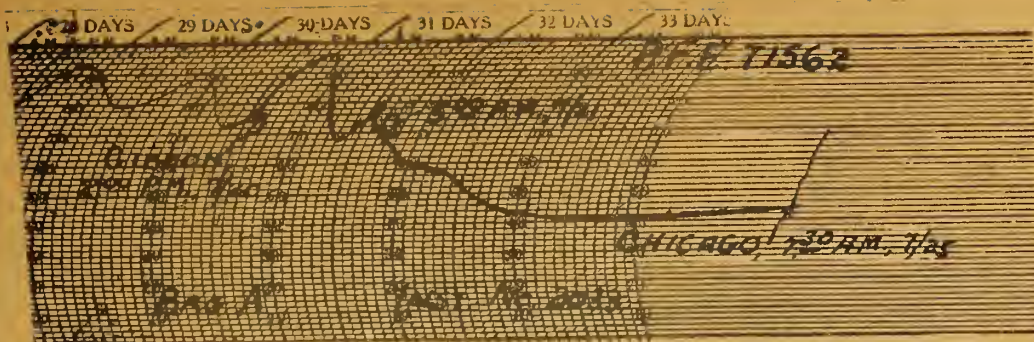


### Nebraska 1942-2

PFE 51248 - 30,000-pound load. Preiced to capacity and reiced at Council Bluffs. Vents closed to destination.





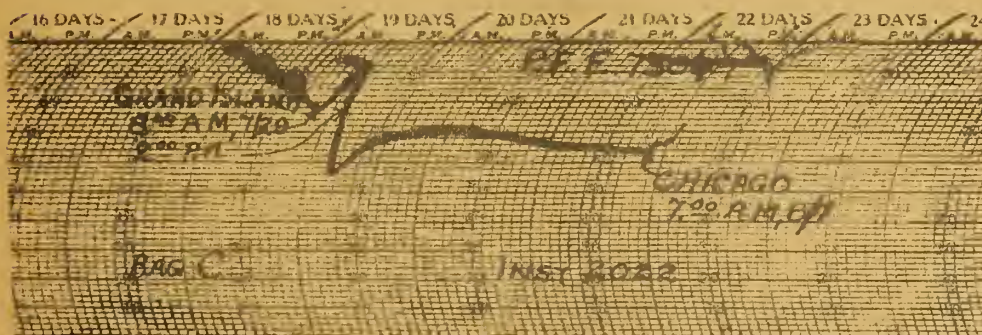
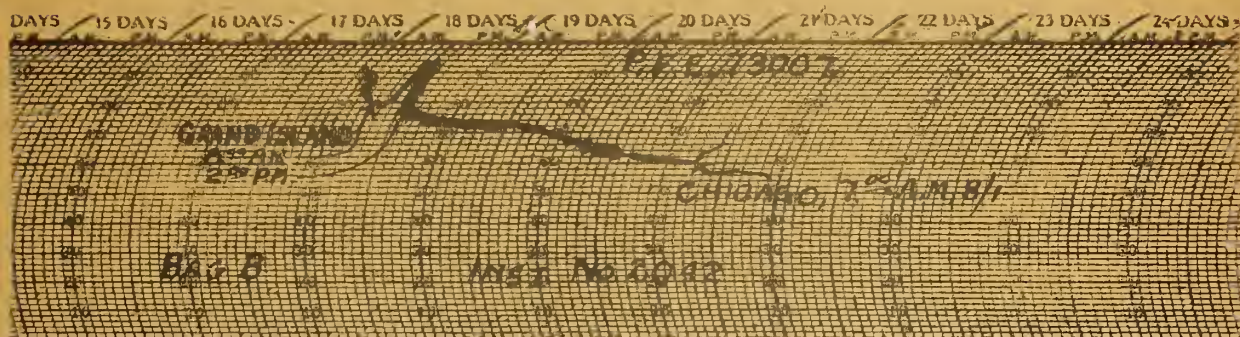
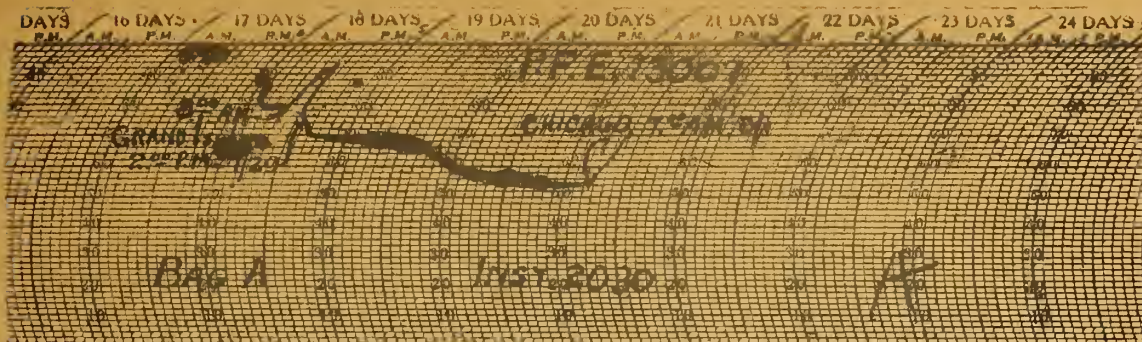


Nebraska 1942-4

PFE 71562 - 30,000-pound load. Preiced to capacity, not reiced in transit. Vents closed to destination.





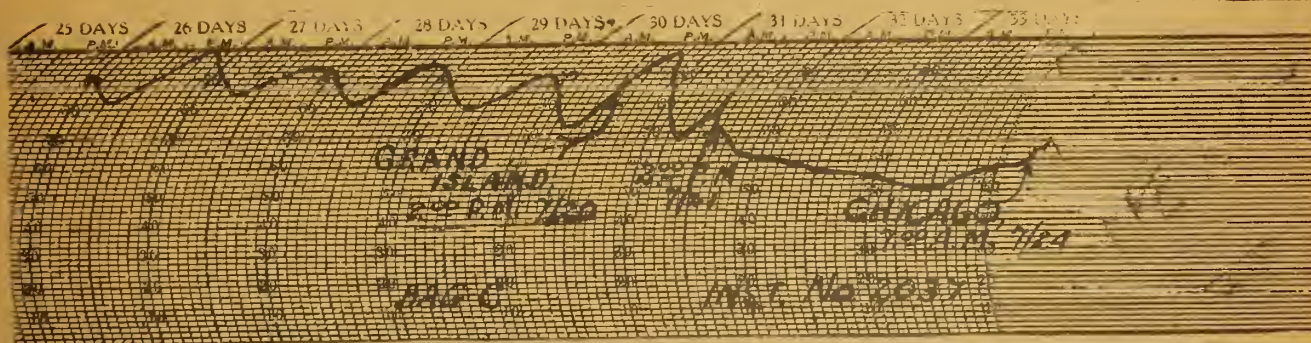
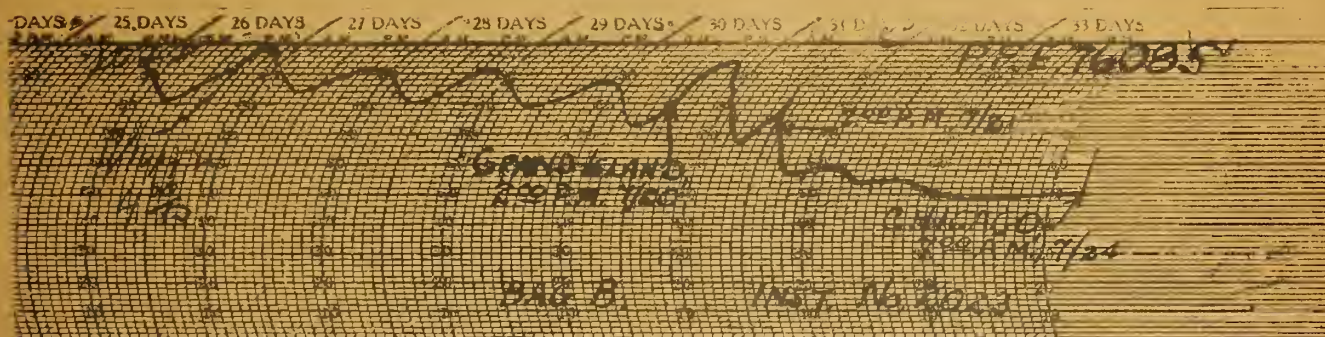
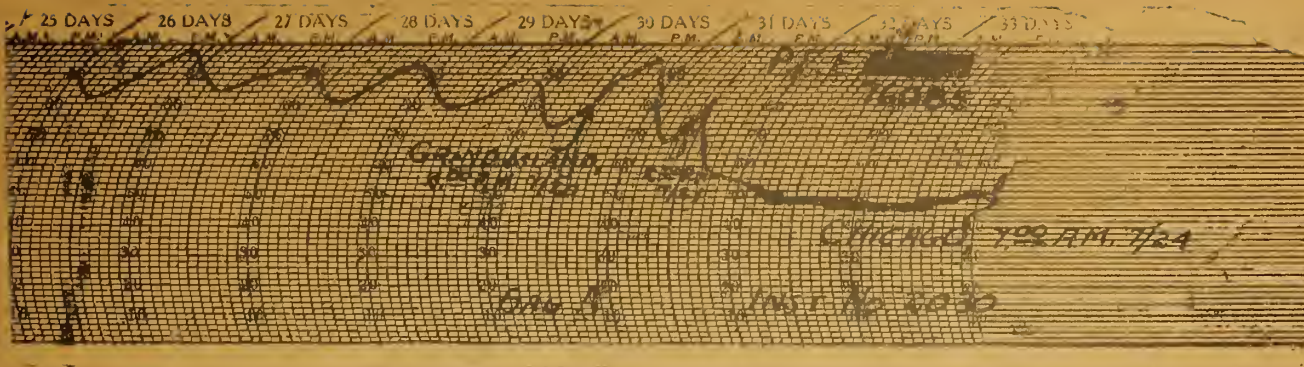


Nebraska 1942-7

PFE 73007 - 30,000-pound load. Precooled 2 1/2 hours by Shippers' Precooling Service. Two and one-half tons of ice added in upper half stage at Council Bluffs. Vents closed to destination.





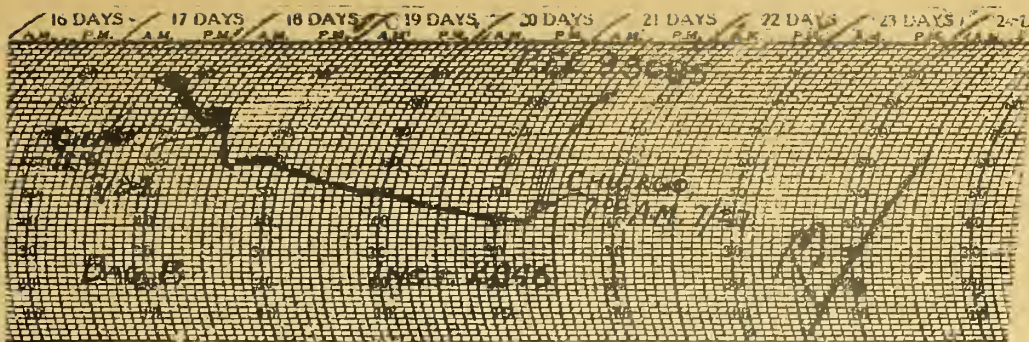


# Nebraska 1942-4

PFE 76085 - 30,000 load. Preiced (3 tons). Cooled with built-in floor fans run by electric motor for 5 hours after loading. Fans run from car wheel and vents closed to Galesburg. Fans disconnected and vents opened from Galesburg to Chicago.

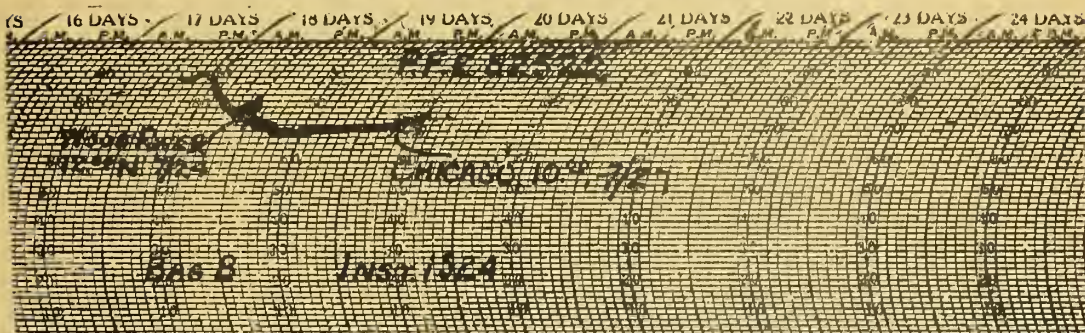






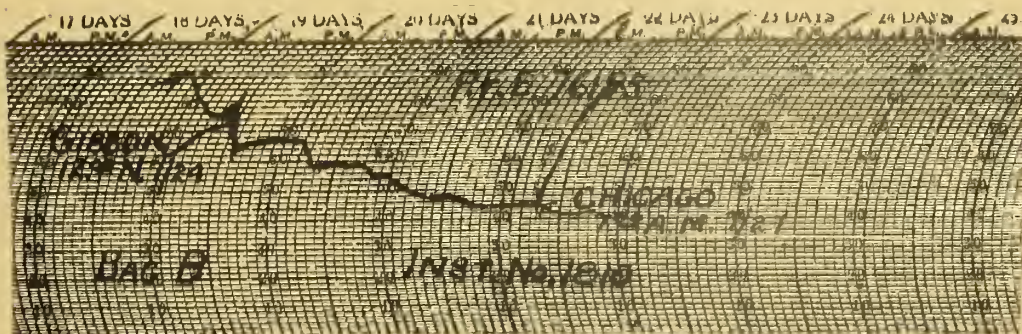
Nebraska 1942-6

PFE 93095 - 30,000-pound load. Preiced to capacity and reiced at Galesburg. Vents closed to destination.



Nebraska 1942-6

PFE 52522 - 30,000-pound load. Precooled 2 hours, 45 minutes by Shippers' Precooling Service. Vents closed to Galesburg and open beyond.

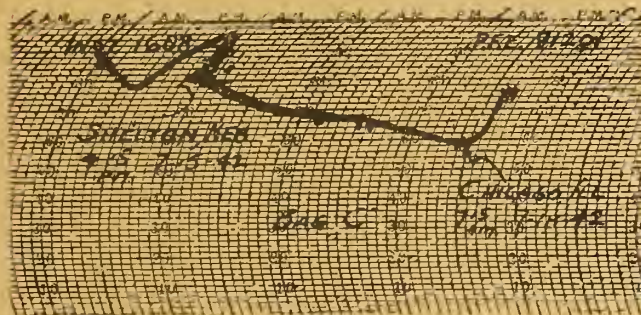
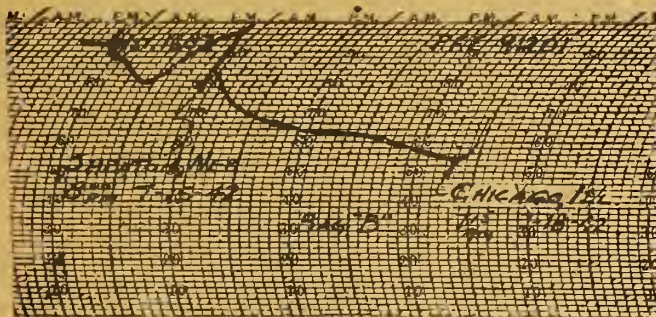
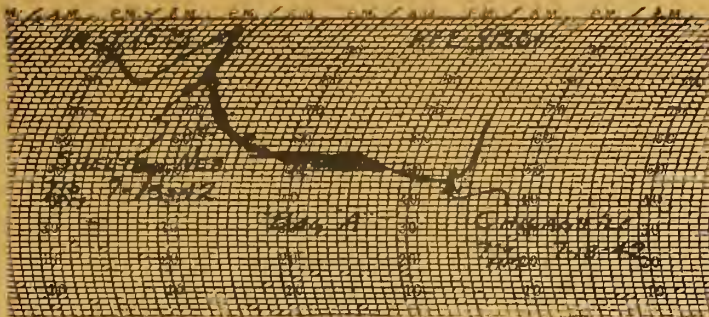


Nebraska 1942-6

PFE 76155 - 30,000-pound load. Preiced to capacity and reiced at Galesburg. Vents closed to destination. Built-in floor fans operated from car wheels from Gibbon to Galesburg, disconnected beyond.





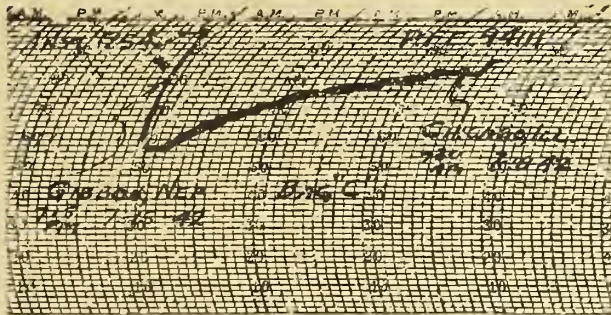
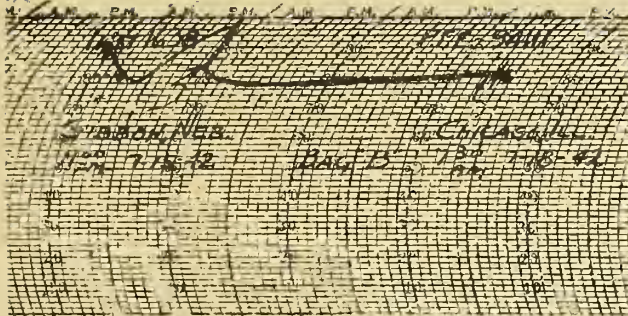


Nebraska 1942-1

PFE 91201 - 30,000-pound load. Preiced to capacity (10,600 lbs.)  
and reiced at Galesburg with 9,100 lbs. Vents closed  
to destination.



No record of Bag A

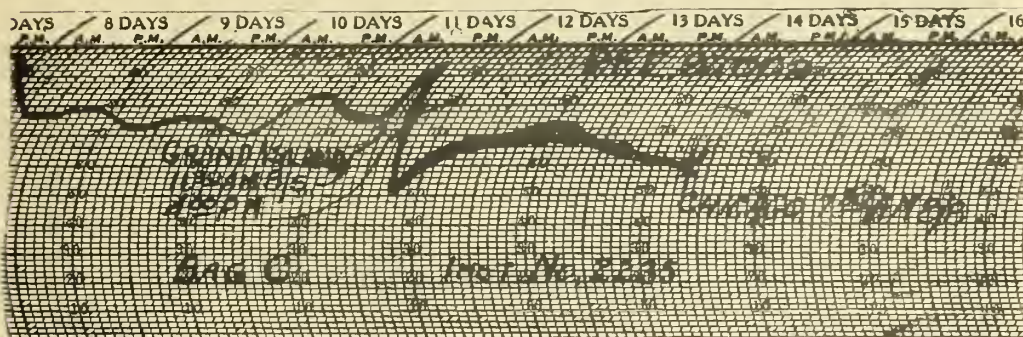
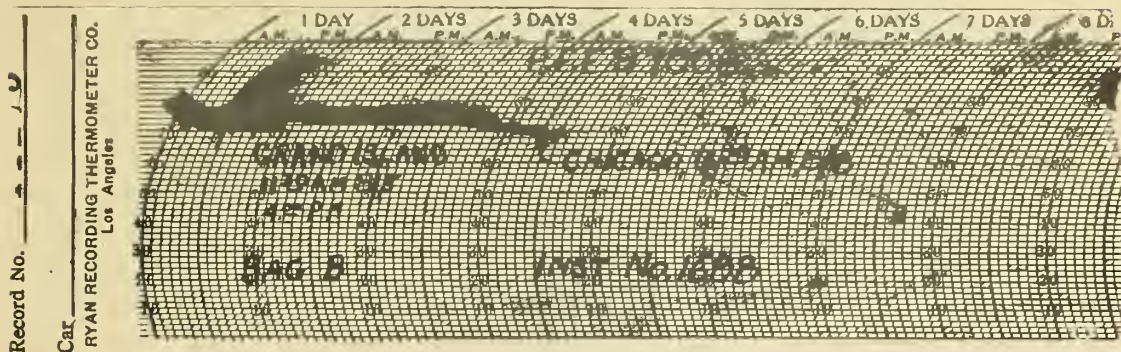
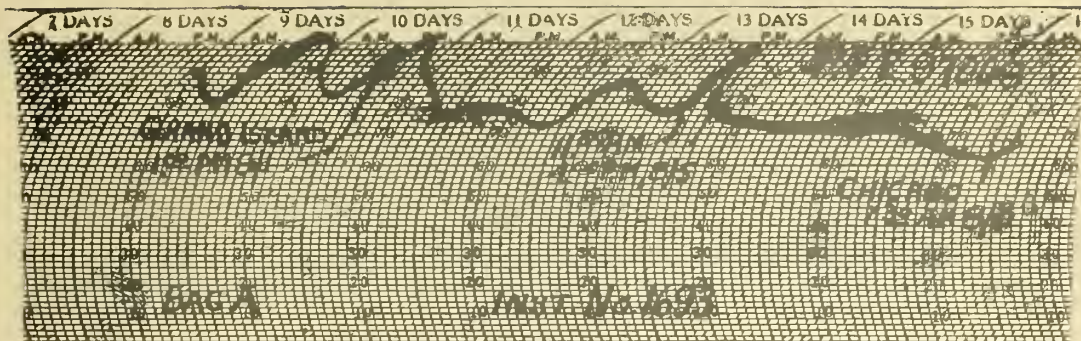


Nebraska 1942-1

PFE 94111 - 30,000-pound load.      Precooled 2 hours by Shippers'  
Precooling Service.      Vents closed to Galesburg, open  
beyond.





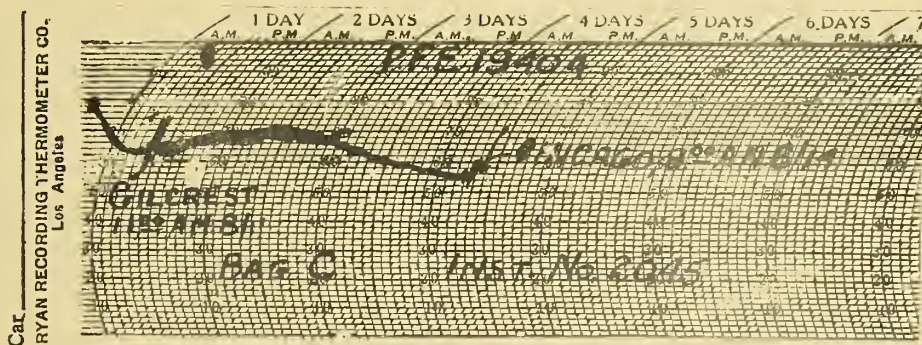
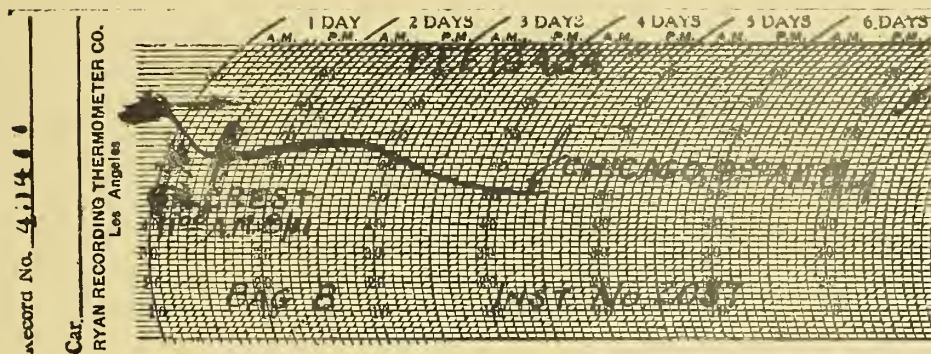
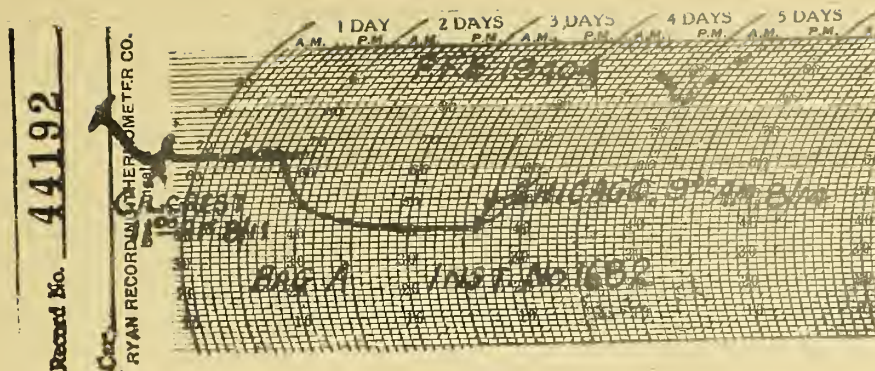


# Nebraska 1942-8

PFE 97009 - 30,000-pound load. Precooled 2 1/2 hours by Shippers' Precooling Service. Vents closed to destination. One ton of ice added to each bunker at Clinton, Iowa.







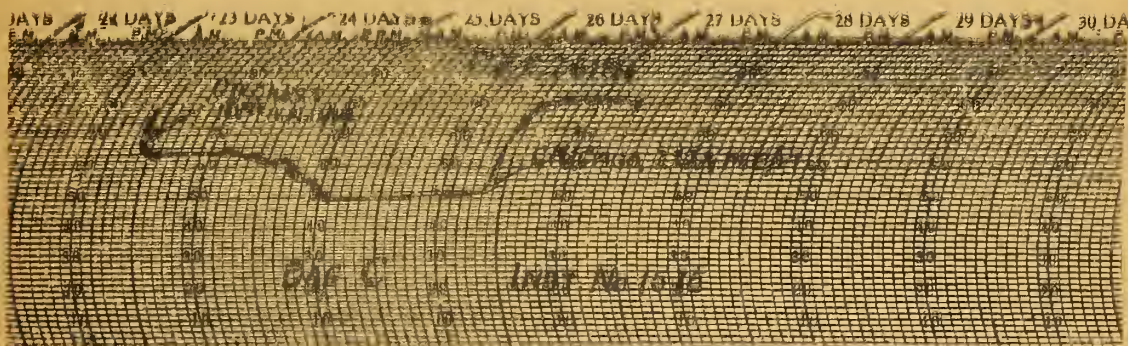
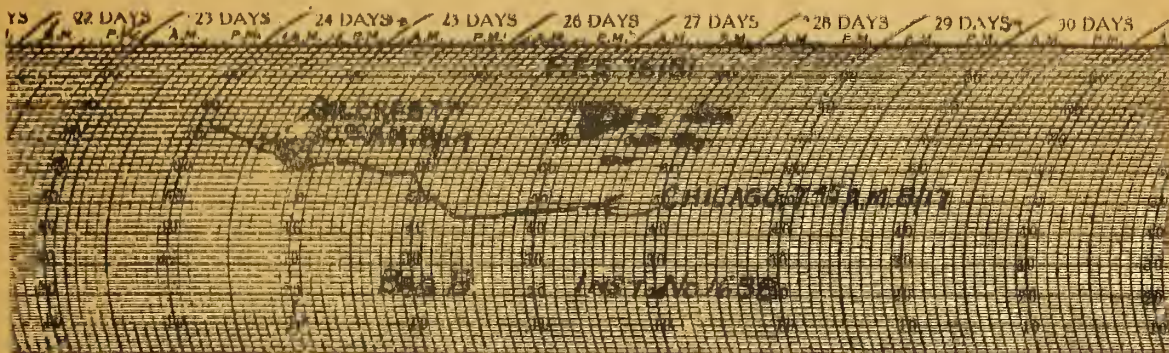
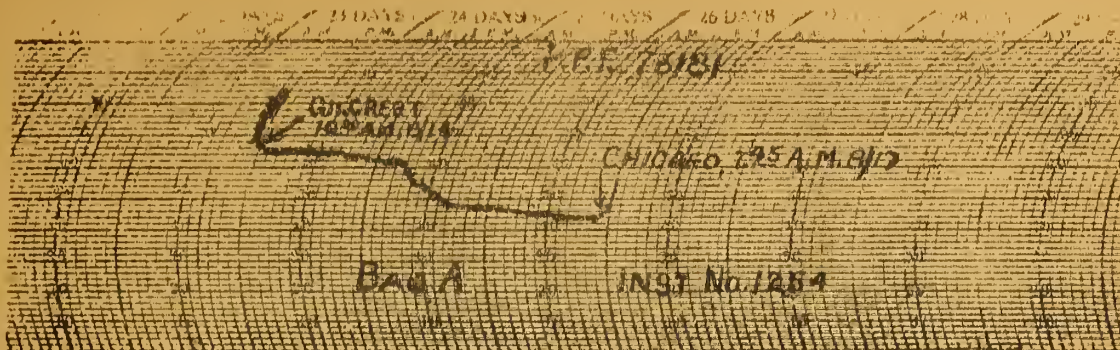
Colorado 1942-1

PFE 19404 - 36,000-pound load. Standard ventilation to North Platte.

Iced to capacity at North Platte. Vents closed to destination.







# Colorado 1942-4

PFE 76181 - 36,000-pound load. Standard ventilation to North Platte, there iced to capacity and vents closed to destination. Floor fans operated by car wheels, Gilcrest to Omaha; off beyond.

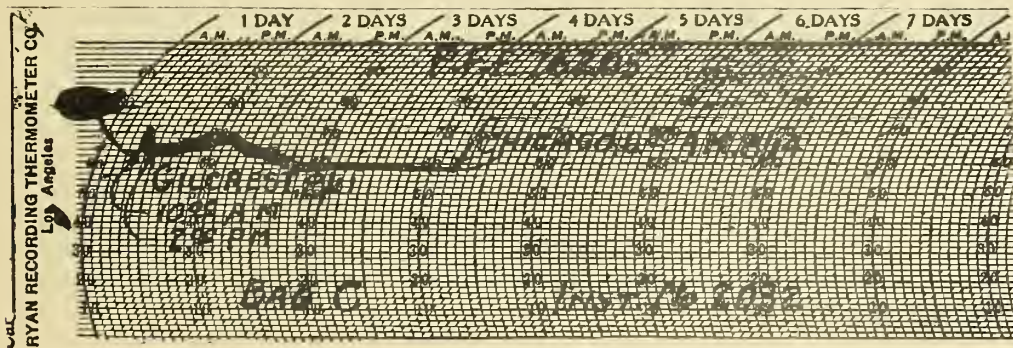
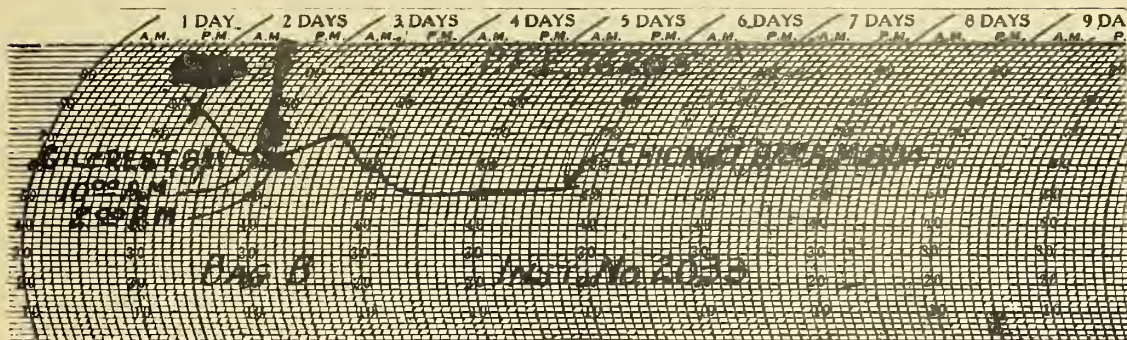
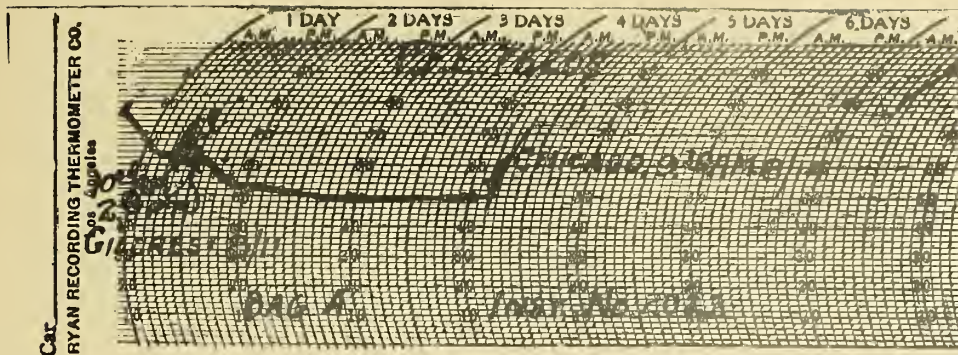












### Colorado 1942-1

PFE 76205 - 36,000-pound load. Preiced to capacity at Denver, not  
reiced. Vents closed to destination. Built-in floor fans  
operated to Council Bluffs, disconnected beyond.

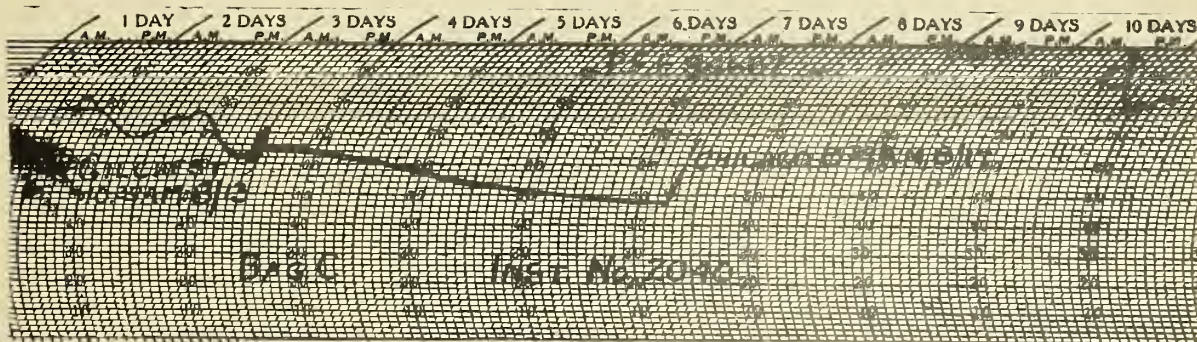
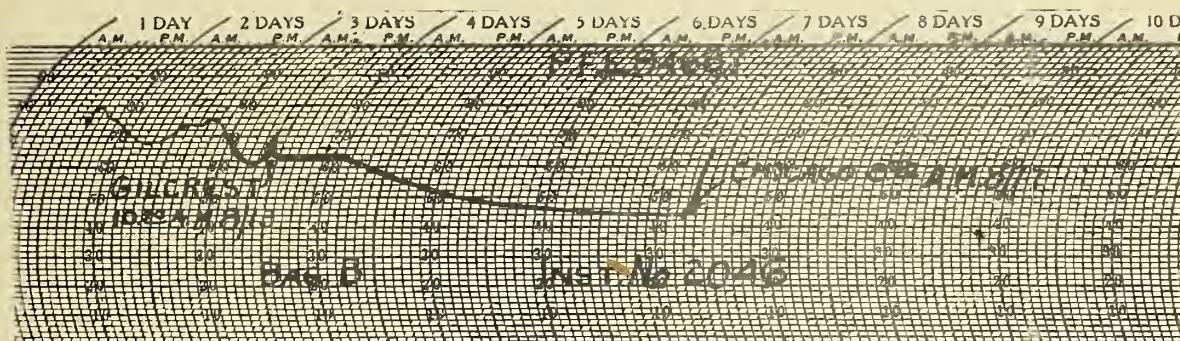
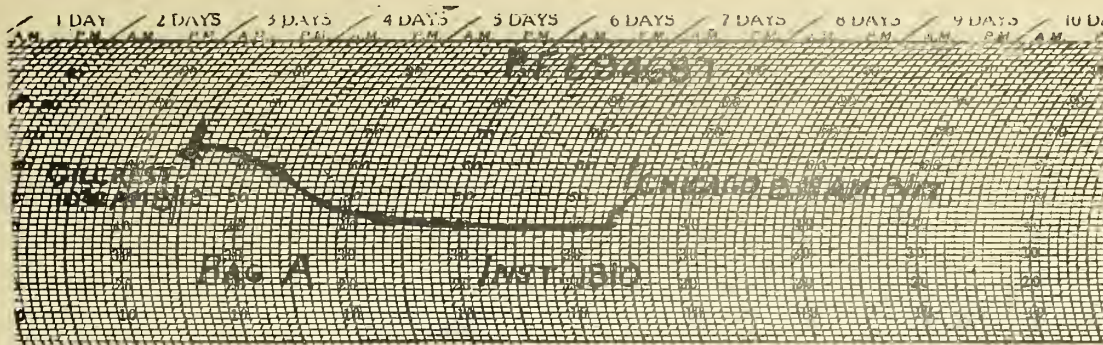












### Colorado 1942-3

PFE 94687 - 36,000-pound load. Standard ventilation to North Platte,  
then iced to capacity and vents closed to destination.

